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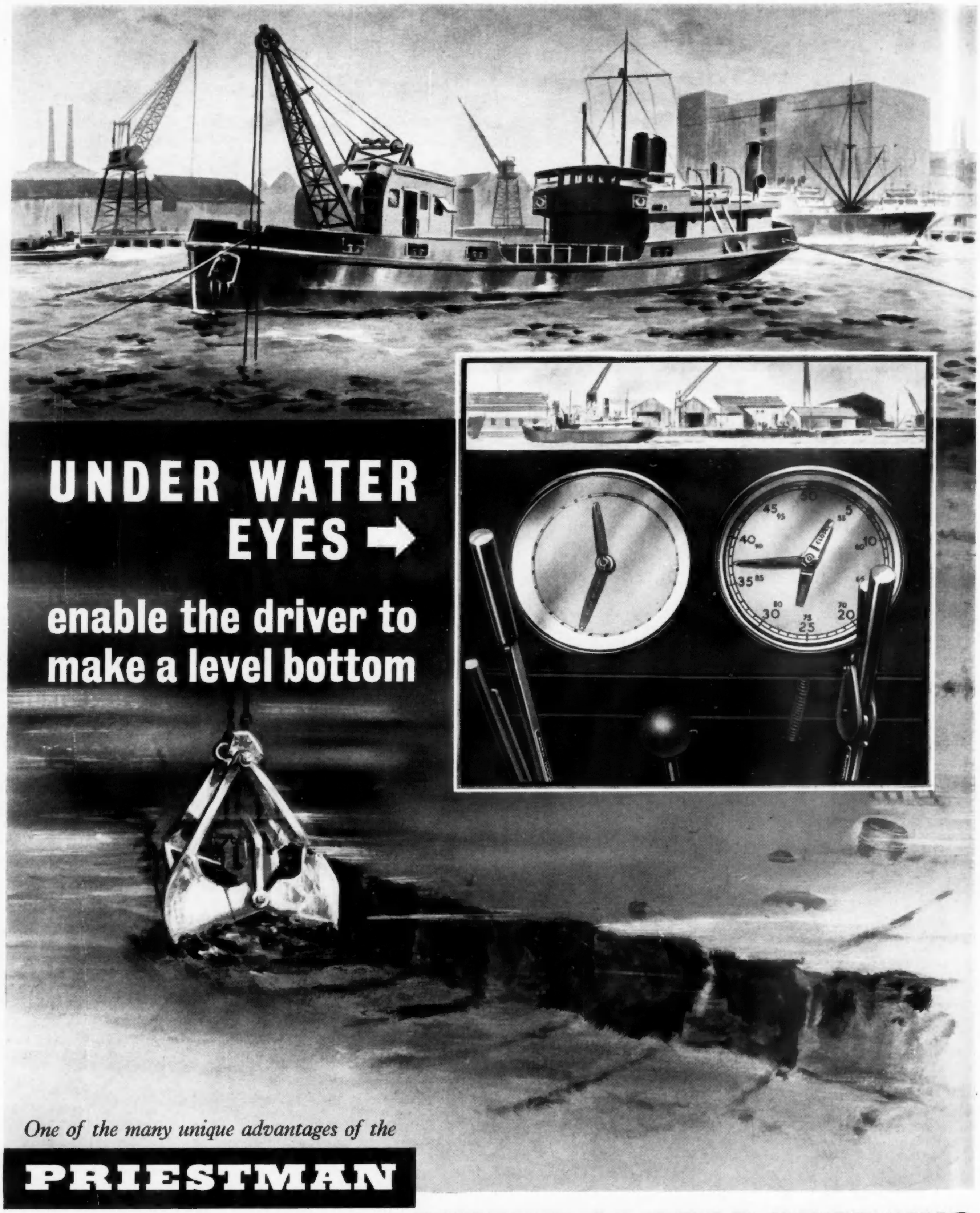
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The Dock & Harbour Authority

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No. 446

Vol. XXXVIII

DECEMBER, 1957

Monthly 2s. 6d.

Editorial Comments

Seasonal Greetings

The Editor and Staff of "The Dock & Harbour Authority" take this opportunity to send to all their readers sincere Christmas Greetings and all Good Wishes for the New Year

Modern Facilities at No. 102 Berth, Southampton

This new passenger and cargo terminal which handles the major part of the South African traffic of the Union-Castle Line, has now been in use for nearly two years. During this time the operation of the terminal has demonstrated that the design and layout of the modern facilities which have been provided has been justified in every respect.

The two-storey transit cargo and passenger building is interesting in that a very successful attempt has been made to provide adequate up-to-date facilities under one roof for the movement of both passenger and cargo traffic, together with such advantages as an internal passenger platform, access for fork-lift trucks across the passenger track, modern administrative offices and electric crane service direct from the shed to rail loading bays, as well as means for the mechanised loading of motor transport. To meet these requirements it was necessary to provide a "mechanised" upper floor designed for a live loading of 3 cwts. per square foot, and it is worthy of note that the cost of the heavy form of construction necessary has been amply justified.

Our leading article this month includes a general account of the operational requirements of the scheme, the design considerations of the structure and the cladding, and notes upon the architectural treatment of the front and rear elevations of the building and of the passenger terminal facilities.

The Tyne Tanker Cleaning Berth

This berth, the first provided in Britain exclusively for the purpose of cleaning the tanks and bilges of ocean-going oil tankers, was designed to accommodate vessels in ballast, and for over two years has been in continuous use by a succession of large tankers en route for dry-docking or repair.

Although constructed for the berthing of vessels of up to 26,000 D.W. tons with a draft of 25-ft., it will be seen from the article describing the design of the berth—which is included in this issue—that much larger vessels could be safely accommodated. The energy-absorbing fendering system allows for a berthing speed of one foot per second — a high figure for the controlled conditions obtaining in a sheltered waterway. There seems to be no reason why the unique arrangement of energy-absorbing dolphins could not be scaled up in size to provide a design for the safe reception of the largest super-tankers.

The Milford Haven Conservancy Authority

The proposed development of Milford Haven, one of the finest natural deepwater harbours in Western Europe, has received much publicity during the last few years and a number of alternative schemes have been suggested by the Milford Docks Company, several oil companies and other commercial interests. These many conflicting points of view made it essential that an overall body to plan the general development of the area should be established, and last month the Milford Haven Conservancy Bill was formally presented in Parliament. This setting up of a Conservancy Authority by legislation as an act of Government policy is without modern precedent in Britain.

The Bill proposes that the Milford Haven Conservancy Authority should comprise a board of 17 members, including a chairman appointed by the Minister of Transport and Civil Aviation. Waterside frontages providing dock and other facilities for dealing with ships will be represented by four members. Shipowners will also have four representatives and trawler owners one. Pembroke County Council will appoint four members, one after consultation with organised labour. The Admiralty, Trinity House and the local sea fisheries district committee will each appoint one member and the other will be appointed by the Minister at his discretion.

The Board will be authorised to levy dues as specified. They may borrow or issue stock, on the security of their revenue and property, up to £850,000 for capital purposes and up to £150,000 during the first six years for the payment of expenses chargeable to revenue.

The duty of the Board will be to maintain, improve, protect and regulate the navigation and, in particular, the deepwater facilities, in the area defined by the Bill, which extends from the mouth of the Haven landwards as far as the tide flows. This is approximately as far as Haverfordwest on the Western Cleddau river and Canaston Bridge on the Eastern Cleddau. The Board will be able to acquire land by agreement and to carry out works, to dredge and to deal with wrecks.

Moving the second reading of the Bill in the House of Commons, the Minister of Transport and Civil Aviation said the tendency in the sea-carrying trade was towards even larger ships "particularly for oil and ore cargoes. There are 260 tankers of over 40,000 tons building or projected on a world-wide basis and 59 of these are over 60,000 tons, so it is right to look ahead to a time when berthing facilities and harbouring facilities will be needed for these larger ships. The events of twelve months ago taught the maritime world that it was wiser to be less dependent on the use of the Suez Canal and so again there is a pressure for larger tankers and larger vessels of all kinds. This trend will continue. The Government foresaw this development and urgent examination was put in hand of all possible ports and harbours

Editorial Comments—*continued*

that could be made available for these much larger ships. Milford Haven was obviously an outstanding choice."

Besides being beneficial from the point of view of navigation, berthing and the harbourage of large vessels, the proposed improvements will also offer great advantages in the commercial and industrial development of West South Wales. The British Petroleum Company, the Esso Company and the Milford Docks Company have already received Parliamentary sanction for private Bills which are all concerned with the industrial development of the area, and the Steel Company of Wales is known to be interested in the Haven for the future handling of large ore carriers.

Paying for Suez

The question of who shall pay for the cost of clearing the obstructions in the Suez Canal has been under discussion for months past and at the time this issue was going to press no definite decision had been reached. It was back in the summer that the Secretary-General of the United Nations, Mr. Hammarskjold, put forward the proposal that there should be a surcharge on the transit dues paid by those who use the Canal and a figure of 10 per cent. was mentioned. This caused an immediate outcry on the part of shipowners. They felt that a principle was at stake. They argued, and it must be admitted rightly, that they were no more responsible for the blocking of the Canal than any other industry and that it was unfair that they alone should be burdened with the cost of undoing what, after all, was the baneful act of the Egyptian authorities.

Now the Secretary-General estimates that on the present level of canal traffic the revenue from a 3 per cent. surcharge would pay the cost of the clearance in three years. This revenue would be used to reimburse the eleven countries which made advance loan contributions totalling nearly 11¾ million dollars to enable the United Nations initially to meet the costs involved. The reduction of the levy to 3 per cent. does not alter the principle and in any case a number of important issues arise. The Egyptian authorities have stated that they will have nothing to do with the collection of the proposed surcharge. How, then, is it to be collected? The United Nations have no authority to impose their decisions on their members. Individual Governments could, presumably, pass legislation which would enable them to pay the surcharge and then levy their Canal-using shipowners, but it would be a clumsy procedure and it is not difficult to think of Governments who would decline to do anything in the matter and, indeed, of some shipowners in certain countries who would resolutely refuse to pay, unless the proposal was accompanied by sanctions.

The total cost of clearing the canal was 8.3 million dollars. The biggest advance to the United Nations was made by the United States—five million dollars—and there has been a rumour that America might be prepared to forego reimbursement of her share of the cost. That would be a magnanimous gesture, but shipowners will still feel that, however small the balance left might be, the amount should be spread over the community as a whole. That remains the attitude of British owners and Viscount Simon, the president of the Chamber of Shipping, has let it be known that this view has again been strongly impressed on the Government.

Investigations of Shipyard Sites in India

As our readers may recall, it was announced in these columns last September that a mission was shortly to be sent to India, under the joint auspices of the Colombo Plan and the United Kingdom Shipbuilding Conference, to advise on the construction of additional shipbuilding facilities and, more particularly, on the location and layout of a new shipyard which would supplement the existing yard at Vizagapatam. Last month the mission completed a fortnight's tour of possible sites in Calcutta, Cochin, Karwar, Kandla and Trombay and also paid a short visit to the shipyard at Vizagapatam and the marine research station at Poona. Before this, an advance party had inspected a further five possible sites so that, altogether, thirteen sites were visited.

There have been many claims by those states situated on the Indian seaboard for the yard to be built in their territory and, after final consultations with officials, the mission will make a special report to the Indian Government, probably by April next. Mr. James Lenaghan, leader of the mission, said recently in New Delhi that building the shipyard would provide considerable employment and that material produced in India would be utilised to the greatest possible extent. Although he declined to disclose which site the mission would recommend, Mr. Lenaghan stated that the report would cover the establishment of a shipyard, which would take about two years to build and would be capable of constructing ships of from 10,000 to 60,000 tons deadweight.

A decision on who will construct the yard will be taken after the mission has submitted its report. Early last month, it was announced that the Indian Government was considering offers from Japanese firms who were interested in the project. Three other countries, Great Britain, West Germany and Yugoslavia, have already indicated that they would be prepared to undertake the work, so it appears likely that very competitive tenders will be submitted. In view of India's uncertain economic position, however, it is probable that the final decision will be governed to a large extent by the financial credits that can be arranged.

U.N. Development Scheme for Mekong River

It was recently announced by the United Nations Organization that a technical assistance mission has been appointed to conduct a three-month investigation of projects for the development of the Lower Mekong River Basin, which serves the four riparian countries of Cambodia, Laos, Thailand and Vietnam.

The mission will examine three specific projects which were recommended by the Economic Committee for Asia and the Far East, namely, the construction of a dam above Vientiane, capital of Laos, for irrigation, navigation and hydro-electric power purposes (Pa Mong project); similar improvements in the middle reaches of the river by the construction of a second dam (Sambor project); and the construction of a barrage that would regulate the flow of water between the Great Lake — a natural reservoir near Phnom-Penh—and the Mekong (Tonle Sap project). The mission will also submit recommendations on further studies to be undertaken for an overall development of the resources of the Mekong Basin.

The Mekong, which is some 2,600 miles in length, is one of the major rivers of the world and its origin in the snowy mountains of Tibet gives it a comparatively steady year-round supply of water. The drainage area amounts to about 235,000 square miles and experts estimate that by building storage barrages that would allow utilisation of the present net run-off, irrigation facilities could be provided for an area of about 23 million acres, which is considerably more than the present 14 million acres under cultivation.

The development would also assist in the control of floods, which at present inundate several million acres of land every year. In particular, the Great Lake which is connected with the Mekong by a natural canal, the Tonle Sap, and acts as a huge natural reservoir could be used in overall flood schemes. Where hydro-electric power is concerned, it is estimated that ultimately the Basin could provide 4.21 million kilowatts energy per year.

Development of inland navigation will also play an important part in the scheme. At present the river is navigable only in parts, but it could be made totally navigable and so provide much improved water transport facilities to and from the interior.

An ambitious scheme of this nature obviously can only be carried out in stages over a period of years, so it is not surprising that already a considerable time has elapsed since investigations and studies were started by the United Nations in 1951. Realising the need for co-operative action, the four interested countries met last May and established a committee which held its first session two months ago in Phnom-Penh, capital of Cambodia.

This proposed development may be likened in scope and potentiality to the Tenessee Valley Authority project in the United States and, if completed, would effect considerable economic changes in south-east Asia and contribute greatly to an improvement in the living standards of the local population.

Passenger and Cargo Building at Southampton Docks

Modernisation of Facilities at No. 102 Berth

(Specially Contributed)

Introductory

THE passenger and cargo terminal which was officially opened by the High Commissioner for the Union of South Africa, Mr. G. P. Jooste on January 25th, 1956, replaces a single-storey transit shed which was destroyed by enemy action at Berth 102 in the New Docks, and is used principally for dealing with cargo and passengers from the inward mail liners of the Union-Castle Mail Steamship Company engaged on the South African Traffic service. The terminal has now been in operation for nearly two years and has fully justified the expectations of the designers in being able adequately to cope with the heavy weekly cargoes received from the Union, whilst the high standard of the passenger accommodation provided has created a most favourable impression.

History

The ocean link with South Africa is maintained from Southampton by the Union-Castle Line, whose predecessor, the Union Steamship Company, began operating a mail service to South Africa in the year 1857 under a Government contract, one of the conditions of which stipulated that the journey should not take more than 42 days each way. Amalgamation with the Castle Packet Co. in 1899 produced the present company, and provided it with the inherited series of ships' names which is still maintained. To-day eight Union-Castle liners with their handsome lavender-grey hulls and black and red funnels operate a service of clockwork punctuality, one liner sailing at 4 p.m. every Thursday from the New Docks for South Africa, to pass in the Channel a sister ship homeward bound scheduled to berth at Southampton at 5.45 a.m. the following day.

From 1920 to the beginning of the last war, the mail liners of the Union-Castle Line were handled entirely at the southernmost area of the Old Docks but, with the introduction in the 1930's of larger vessels on the South African service, with their greater carrying capacity, the berths and accommodation in that area soon reached saturation point, and it became evident that consideration would have to be given to the provision of new accommodation on up-to-date lines to deal with the traffic.

The Second World War deferred the consideration of schemes of reconstruction but early in 1947, partly because of the Union-Castle Line's decision to introduce even larger ships, and the fact that they had contracted to take the whole of South Africa's fruit exports for a number of years, it because essential to extend the facilities at Southampton to handle the increased traffic within a turn-round time adequate to maintain a weekly service. It was then decided to concentrate the South African traffic at the New Docks and to provide up-to-date facilities for dealing with passengers and cargo carried by inward Union-Castle liners. This decision was to some extent influenced by the destruction by enemy action of the existing single storey shed at Berth 102.

General Description of the Building

The new Terminal, which was commenced in 1952, consists of a two-storey transit cargo and passenger building, its dimensions being approximately 932-ft. long overall and 162-ft. at its widest (centre) portion. The height from ground level to first floor is 25-ft. 6-in., with the eaves and ridge at 19-ft. and 28-ft. 6-in. respectively above the first floor. The minimum headroom on the first floor is 18-ft., and on the ground floor 17.5-ft., at the seaward side diminished to 14.25-ft. at the back of the building by the rise of the ground floor level to standard platform height, i.e., 3.25-ft. above rail level. The accommodation provides about six acres of covered area for cargo and passenger use.

The ground floor is used for passengers and their baggage, and for perishable cargo and wine, the upper floor (Fig. 1) being primarily used for such cargo as wool, skins and hides, together with certain cased goods, a ship's load of which may be up to 7,000 tons.

Annexed to the building on the North side is a semi-open gantry crane bay 442-ft. long by 20-ft. wide, containing four electrically operated traversing cranes, each of 30 cwt. lifting capacity, which are used for the transfer of cargo from the upper floor direct into railway wagons below at ground level or to the adjacent rail platforms within the building. On the South or quayward side is a single storey portion some 640-ft. long and 34-ft. wide, the upper level serving to provide a landing platform whence cargo is distributed by battery operated 2 ton platform trucks and 30 cwt. fork-lift squeeze clamp type trucks. The transfer of cargo from ship to shore is performed by 3 or 6 ton 86-ft. radius electric level luffing quayside cranes, eight of these being normally available at the berth.

The northern or landward side of the ground floor working area is terminated by a rail platform—which continues into and through the adjoining Shed 101, and is used for passenger boat trains to Waterloo and for freight trains. On the outer side of the rail track is an island platform some 515-ft. long by 16-ft. 3-in. wide for the handling of cargo lowered from the upper floor by the gantry cranes. When necessary, use is made of the island platform for the loading away of cargo from the ground floor, and for this purpose three electrically operated lifting bridges are installed in permanent positions at points along the platform to span the gap formed by the intervening "gullet road." The bridges which are of steel construction with timber decks, are some 12-ft. in width, and are designed to take a fully loaded fork-lift truck the total weight of which is about 4½ tons. Automatic warning signal lights at the entrances to the building indicate whether the bridges are up or down.

Facilities for the discharge of cargo to road transport are provided by three 30 cwt. electric traversing hoists at high level above open wells in the first floor at the West end of the building, below which is a loading platform of the echelon type 3-ft. 6-in. high above the ground floor with room for the docking of six lorries at any one time. At two of the docking positions lorries can be brought directly under the hoists just mentioned.

A gear lift of 3 tons capacity provides for the transfer of mechanical equipment between the upper and lower storey levels; and this, in turn, facilitates the speedy removal for re-charging

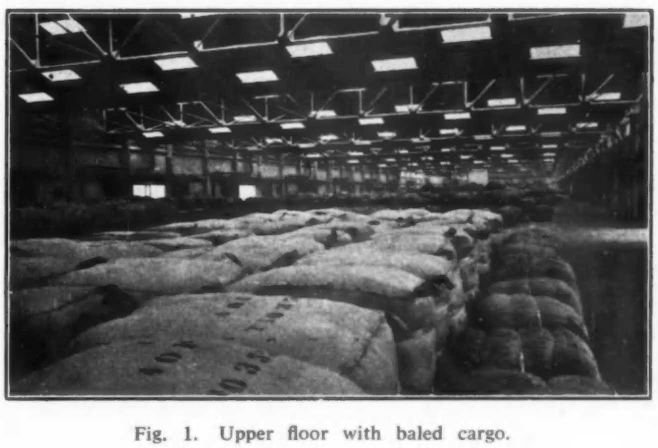


Fig. 1. Upper floor with baled cargo.

Passenger and Cargo Building at Southampton Docks—continued

Fig. 2. South elevation from quay.

of battery operated equipment such as fork-lift or platform trucks, etc., which form the bulk of the appliances used in the building.

At the East end of the ground floor working area are two large enclosed spaces for the temporary storage and securing of bonded cargo, duty paid cargo and for gear, above one of which, on the quayward side, is office accommodation for Shed Operating Department's staff. Further offices of chalet type are provided at the south-western end of the building.

The eastern section of the building, which is about 196-ft. long and reduced in width to 90-ft. contains at the ground floor level, a spacious Waiting Hall complete with all facilities for the needs and comfort of passengers, the description of which together with illustrations of its treatment is given later in this article. Above the Waiting Hall at a mezzanine level immediately below the first floor, are two sets of offices which serve to provide accommodation for general administrative purposes, the shipping companies and H.M. Customs. This accommodation is arranged in duplicate blocks each approximately 196-ft. long, connected at the western end by an internal corridor 90-ft. long. Access to these offices is provided from outside the building and clear of the ground floor cargo area by four sets of stairs, two of which are extended to the first floor.

Routing of Passengers

Passengers arriving or departing are in each case routed through the Waiting Hall from whence entrance can be made either to the ground floor cargo area (or to the adjacent previously existing single-storey Shed 101), where Customs examination is carried out.

The baggage examination tables, which are constructed in aluminium, can be quickly dismantled and nested for economical storage when not required.

Four baggage scales of mobile pattern are provided in recessed positions alongside the rail platform for weighing passengers' baggage, together with desks at which payment for excess baggage is made.

Design Considerations—Building

The introduction of a two-storeyed structure in the uniform development of repetitive single-storey transit sheds along the straight quay some $1\frac{1}{2}$ miles long in the New Docks at Southampton, coupled with the fact that traffic considerations made it essential to have the East end of the new building interconnected with the adjacent Shed at Berth 101, raised an interesting architectural problem of considerable complexity. While the buildings as at present existing—which were built in the early 1930's—offer quite an orderly and straight-forward expression when considered as a whole, besides being hitherto perfectly satisfactory from an operational standpoint, the elevational treatment nevertheless represents a style which has become obsolete by modern standards of contemporary design.

It was felt, however, that some acknowledgment should be made in the new scheme to the existing development, in order to preserve as far as possible, the continuity of the quayside appearance with its brick and concrete treatment. A brown coloured brick was therefore selected for the facing to the ground floor portion of the building throughout including the end elevations, and to give a framing effect to the long upper parts of the North and South sides, the main body of which by way of contrast, is faced with a buff coloured brick patterned with dark headers.

It was intended that the elevational design should endeavour to give some expression to the functional character of the building and with this aim in view the planning arrangements have been projected visually; the lower working area with its internal stanchions being expressed by the recessed walling and exposed column treatment, while the upper storey with its large unbroken floor area is correspondingly indicated by the long flat surface treatment given to its elevation.

The shape of the "umbrella" roof construction described below is functionally represented on the long sides to the building by the series of low-pitched gables that flow from one end to the other. For reasons of continuity the gables are treated as subsidiary units in the general composition of the scheme, and are set back from the main face of the building and infilled with a double thickness of asbestos cement sheeting to emphasise the non-structural aspect of the cladding at this point (Fig. 2). Windows at the clerestory level run the full length of the building on both sides and are primarily intended for cross ventilation purposes. Top hung ventilators serve the opening portions to the windows and these in all cases are controlled by a system of tension cable gearing, electrically operated by remote control to prevent unauthorised or indiscriminating use.

By way of contrast and to avoid the high maintenance cost of metal installations, the window construction to the whole of the ground floor is comprised of glass block units size $7\frac{3}{4}$-in. by $7\frac{3}{4}$-in. by $3\frac{7}{8}$-in. thick, built in situ in generously proportioned areas. Permanent ventilation is provided by special louvred glass blocks.

The sheeting of the crane bay enclosure is asbestos-cement painted blue, the return walls at either end being faced with 5-ft. 4-in. x 4-ft. exposed aggregate concrete slabs with $1\frac{1}{2}$-in. joints pointed in brick red (Fig. 3).

The facing to the office accommodation at the mezzanine level, is of reconstructed stone panels with black pointed joints.

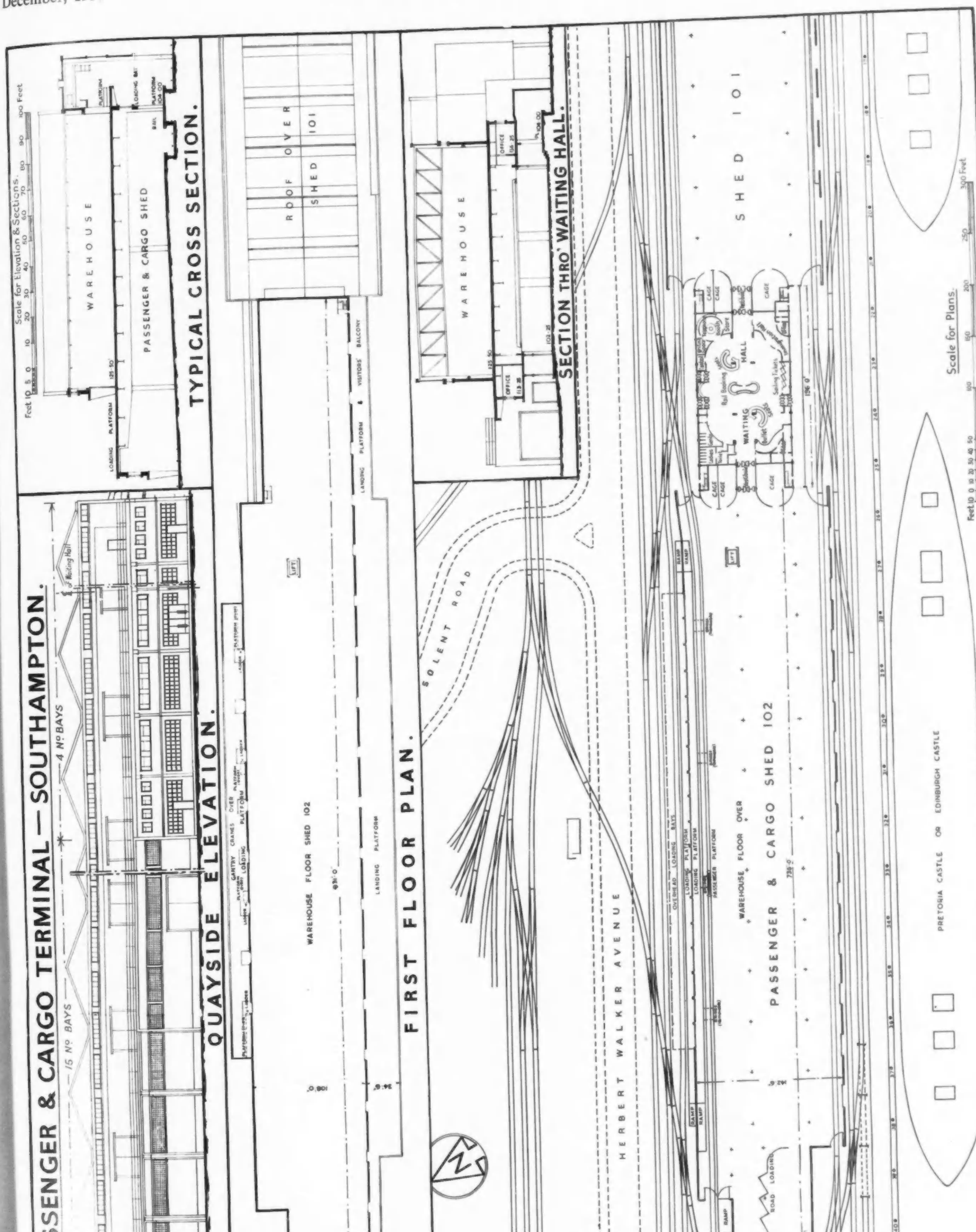
All metal windows and the vertical glazing to the crane bay enclosure, are painted chrome-yellow.

Design Considerations—Structural Steelwork

The main engineering interest in the building lies in the design and construction of the steel framework which has already been described in great detail in other journals devoted particularly to structural problems and which required the use of about 2,300 tons of steel. It will be here sufficient to give an outline of the operational requirements which led to the evolution of the design and a brief description of the manner in which they were met.

For the satisfactory handling of the traffic it was necessary that the transit areas on both floors should be as free from column obstructions as possible. The ideal would have been no column at all in the interior of the building, but while on the first floor with only the roof to support above, this was quite a practicable proposition, on the ground floor considerations of economy in the use of steel and the problems which would have arisen from an over-concentration of the foundation loads at a very few points, made it imperative that at least a certain number of columns should be allowed in the middle of the floor area.

The column spacing finally adopted divided the building into 49-ft. long bays measured longitudinally and two transverse spans of 54-ft. each across the building with supplementary spans on the quayward and landward sides of 34 and 20-ft. respectively. The latter accommodate respectively the first floor landing platform and the crane gantry bay to which reference has already


PASSENGER & CARGO TERMINAL — SOUTHAMPTON.
QUAYSIDE ELEVATION.
FIRST FLOOR PLAN.
TYPICAL CROSS SECTION.
SECTION THRO' WAITING HALL.
Scale for Elevation & Sections.
Scale for Plans.
WAREHOUSE
PASSENGER & CARGO SHED
ROOF OVER SHED 101
WAREHOUSE FLOOR SHED 102
SHED 101
PASSENGER & CARGO SHED 102
WAREHOUSE FLOOR OVER
WAITING HALL
HERBERT WALKER AVENUE
SOLENT ROAD
PRETORIA CASTLE OR EDINBURGH CASTLE
15 Nº BAYS
4 Nº BAYS

Passenger and Cargo Building at Southampton Docks—continued

been made. These relatively wide column spacings coupled with an operational requirement for a load capacity on the first floor of 3 cwts. per square foot, clearly indicated that the columns and beams supporting the first floor would be of very massive construction not usually associated with the building of transit sheds.

It was therefore decided that the circumstances justified the use of an all-welded design both as a means of economising in steel through the elimination of unnecessary structural detail and as an assistance in subsequent maintenance by the elimination of large numbers of rivet and bolt heads which would offer considerable obstruction to periodic maintenance re-painting.

As an example of the type of member which resulted from the application of this technique the main interior columns are of "H" section built up from universal plates having webs 16 to 18-in. deep by 1-in. thick and flanges 20-in. wide by anything from $1\frac{5}{8}$-in. to $2\frac{1}{8}$-in. in thickness. These columns which support a maximum load of about 800 tons each are carried on groups of nine 20-in. diameter West's Rotinoff reinforced concrete piles connected together at the heads by massive reinforced concrete pile caps up to 6-ft. in depth. This type of pile was used throughout,: a total of 576 being driven with an average penetration of 37-ft. below ground level.

The main floor beams run transverse to the length of the building and are continuous over the two 54-ft. spans with a cantilever portion extending some 22-ft. under the first floor cargo landing platform on the quayward side. The purpose of this arrangement was to reduce the load in the outermost row of columns which are supported on the existing quay structure whose capacity to take additional foundation loads was severely limited (Fig. 4).

The beams are of "I" section some 72-in. deep with flanges 20-in. wide and varying in thickness between 1-in. and $2\frac{7}{8}$-in.

The secondary floor members on which the 7-in. thick concrete floor is more generally supported, have an average spacing of 10-ft. and a span of 49-ft. They are designed as continuous girders over the lengths of the four sections into which the building is divided by its three expansion joints, the collapse load or plastic theory being employed in this instance, with an appreciable reduction in the weight of steel used. These girders have a depth of 4-ft. with 12-in. wide flange plates varying in thickness from $\frac{3}{4}$-in. to $1\frac{1}{4}$-in.

In the manufacture of all these members and particularly for the long runs of welding required for the attachment of the webs to the flange plates, automatic welding machines were used and close control was exercised over the order in which the successive runs of weld metal were deposited, in order to reduce the possibility of distortion and the development of locked up stresses to a minimum.

The main transverse girders which with the cantilever portion were some 134-ft. in length and some 34 tons in weight were despatched to the site in two sections to be assembled by means of a welded butt joint located as far as possible at a point of minimum bending moment. The importance of welding of the very highest quality in a joint of this nature needs no emphasis and to secure this, arrangements were made for all welding to be carried out in the down hand position. The two sections of each girder were mounted and clamped together in a rotary manipulator by means of which the girder could be turned over to allow of down hand welding on both faces of the web and on the tops and bottoms of both flanges. The manipulator was re-assembled for each girder in a position from which the girder could on completion of the welding be lifted direct into its final position.

Close supervision of the quality of all welding both in the shops and on the site was exercised by visual inspection and by the examination of all the more important welds carrying heavy structural loads by means of a Solus Schall ultrasonic flaw detector reinforced occasionally by the use of X-ray photographs of individual welds.

The outer pair of columns of the two 54-ft. spans on the ground floor are extended through the first floor to support the main roof girders which are of N type lattice construction and 108-ft. span divided into twelve equal panels of 9-ft. From the top chord panel points, rafters of R.S.J. section extend downwards on each side at an angle of $21\frac{1}{2}°$ to the horizontal and are propped at a distance from the main girder of 13-ft. by strut members rising from the lower chord panel points. Bent T bar slings connecting the rafter ends between each pair of adjacent main girders form the valley, while the top chords of the main girders themselves form the ridges of the roof construction. Nineteen transverse gable-ended bays constructed in this way cover the entire building from end to end. Diagonal bracing is introduced into the planes of the rafters and their supporting struts on one side of each main girder so as to provide a torsion box to resist overturning, due to unequal loading, and progressive collapse of the building (Fig. 5).

Fig. 3. North side with crane bay.

With the exception of the rafters themselves all the members in the roof system were of hollow box section formed of pairs of angles welded toe to toe and sealed at the ends to exclude air. This arrangement reduces the area to be painted of the members in question by about 50 per cent. compared with more conventional forms of construction, a matter of some importance from the maintenance angle. The contractors were offered the alternative of using tubes for all members constructed in this way but the long delivery required for this form of material precluded its adoption.

The entire assembly of roof girders, rafters, struts and bracing members, was assembled on the ground to be lifted into position by the steelwork contractors' Scotch derrick. The total weight to be lifted on each occasion was approximately 14 tons. It will be appreciated that this method of constructing the roof resulted in considerable economies in the cost of erection.

The main frames of the crane gantry bay follow the 49-ft. longitudinal spacing of the primary grid and consist of half portals the free ends of which are supported on the main roof stanchions. Intermediate frames at the one-third points of the 49-ft. span are constructed as full portals with the inner legs supported on the secondary girders of the main first floor steelwork and the outer legs on a continuous lattice box girder which spans between the portal legs of the main frames. The girders carrying the crane gantry rails are of conventional design and call for no comment.

Full scale load and deflection tests were carried out on two of the secondary first floor girders and on one main transverse girder after erection, the instrument used for the measurement of stresses being the Maihak acoustic strain gauge. A full description in detail of these tests and the results to be deduced from them has already been published.

Tests were also carried out on the deflection to be expected in the roof system particularly under conditions of unequal loading. This information was required in connection with the design of the expansion joint between adjacent sections of the building as the extent of movement likely to be experienced at those ridges through which the joint was carried was not known for certain (Fig. 5).

Passenger and Cargo Building at Southampton Docks—continued

General

The ground floor surface, road and railway platforms, were formed in reinforced concrete of 1 : 2 : 4 ratio, and the external walls to the building which are 11-in. cavity construction are carried on reinforced concrete plinth beams spanning 24-ft. 6-in. from pile cap to pile cap. These beams are 4-ft. deep by 15½-in. wide and have a bush-hammered grey granite face.

The five staircases which provide access and communication within the building, are of reinforced concrete throughout, with granolithic finish, the construction being of simple crank-slab design having top and bottom support.

The upper floors, landing platforms, and flat roofs, are of reinforced concrete in situ construction. Those floors subjected to cargo loading and trucking by fork-lift trucks, i.e. first floor storage area and external landing platforms, are provided with a wearing surface of hard grade mastic asphalt in a single layer 1¼-in. thick. Flat roofs are finished in normal quality asphalt in two layers of ¾-in. total thickness.

The stormwater disposal system, for which pressure type asbestos cement pipes were used throughout, is wholly contained within the building.

All members of the structural steel framework in the external walling are encased in concrete for protection against moisture penetration, the cladding having a cover of 2-in. nominal thickness except to those portions exposed externally where the thickness is increased to 4-in.

Internal walls enclosing Waiting Hall, Offices, Staircases and toilets, etc., are of 9-in. solid brickwork or pre-cast lightweight "Lignacite" building blocks, and white sand-lime bricks are used for the inner faces of the external walls to give maximum lighting in the cargo areas.

The partitions forming corridors to the offices at the mezzanine floor level, are of standard metal office type having insulated solid lower panels with vertical reeded glazing above.

Asbestos cement sheeting is employed for the infilling to the series of gables, 38 in all, which terminate the main roof on the quay and landward sides of the building. Similar material, but of a different pattern, is also used for the long side wall enclosing the gantry bay on the landward side, the sheeting throughout being secured from the inside by special clips and the absence of the usual projecting sheeting bolt is a noticeable improvement in appearance. Special consideration was given to the surface treatment of the sheeting where, to obtain a uniform colour and to prevent the customary weather staining effects which all too often in the course of time are features of this material, it was decided to protect the surfaces with a chlorinated rubber paint finish—the gable sheeting being of a neutral grey shade, while

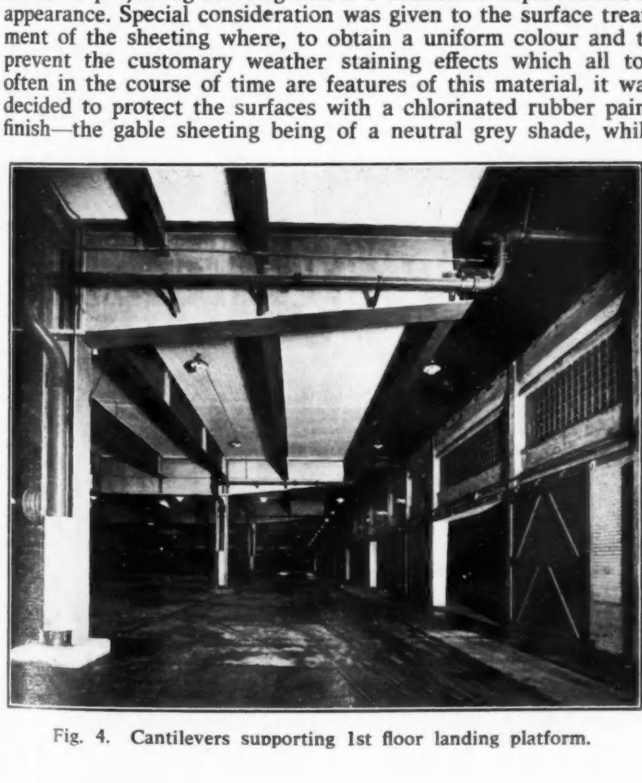


Fig. 4. Cantilevers supporting 1st floor landing platform.

Fig. 5. Roof steelwork showing torsion box and valley slings—also wires supporting deflection test loads.

that to the gantry bay is of a marine blue colour.

The main structure of the building is roofed over with an insulated aluminium alloy decking system, spanning 9-ft. centre to centre of rafters transversely across the building; the system makes use of U section bars spaced 27-in. apart and secured with clips to the supporting steel rafters, flanged deck plates of interlocking pattern being fixed on top to produce a uniformly flat surface. The decking is covered with ½-in. insulating fibre board bonded in bitumen, and waterproofed with a two-layer system of bitumen felt roofing having a green mineral finish.

Roof lighting is provided by means of fixed units 5-ft. by 2-ft. glazed with wired glass, and arranged in "star" pattern for even distribution of light internally.

The building is protected aginst fire internally at each floor level by a first-aid system of hose reels fed from the high-pressure water mains adjoining the building. A total of 32 hose-reels is provided at strategic points within the building—15 being positioned on the ground floor, of which two are located in the Waiting Hall area, and a further 17 on the first floor. In addition, some 40 fire extinguishers of varying type are installed for dealing with outbreaks of a minor nature.

Description of Waiting Hall

The Waiting Hall (Fig. 6), with its ancillary facilities occupies an area some 200-ft. by 90-ft. on the ground floor, and serves as a passenger terminal principally for the Union-Castle Line's ships arriving at Southampton, but can also be used for calling vessels of other shipping lines arriving or departing from the adjoining Berth 101.

On account of the relatively small space available for the main hall, about 100-ft. by 90-ft., the arrangements have been kept on as open a basis as possible in order to give the maximum freedom of movement to traffic in both directions, inwards and outwards, and to limit the necessity for passenger queuing at the entrances. It was also intended too, that the decorative treatment should be thoroughly contemporary with present-day requirements, the combination of informality and simplicity serving to create a pleasant and intimate atmosphere towards which the use of colour makes a stimulating contribution.

The facilities provided in the Waiting Hall include the Immigration Hall, Telephone Hall, Bureau-de-Change, Travel Agencies' Stand, Rail Ticket Office, Writing Rooms, Bookstall, Control Room, Shipping Company's Stand, Toilets and Staff Rest Room. On the North side the accommodation is flanked by the railway platforms, and on the South side by the quay with vestibules approximately 45-ft. long at either end leading to the main passenger and cargo portions of the scheme at Berths 101 and 102.

The height from the ground floor to first floor level is approximately 23-ft., which conveniently allowed for the formation of a

Passenger and Cargo Building at Southampton Docks—continued

suspended ceiling to cover the deep girders and, at the same time, gave useful space for the electrical and other service installations. It also serves to accommodate the ducts for the electrically operated heating and ventilating systems which provides at will for the re-circulation and warming of the air in the hall and its removal and replacement by fresh air as necessary.

The ceiling arrangement is on two levels, the lower and larger area being provided with circular louvred tungsten lighting fittings set in a patterned design; the upper level, which is in a free triangular shape formed asymmetrically between the main four columns in the central area of the hall, is illuminated around its perimeter by a concealed system of cold cathode trough lighting. The lower ceiling is painted in a light shade of blue and the upper in white, and this, coupled with the contrast given by the different types of lighting—direct and concealed, produces a daylight effect over the central area and a relief to the otherwise simple lines of the ceiling treatment.

The decorative surfaces to the walls and partitions are mainly in hardwood flush panelling, the choice of this material being prompted by reason of its serviceability and low cost of mainten-

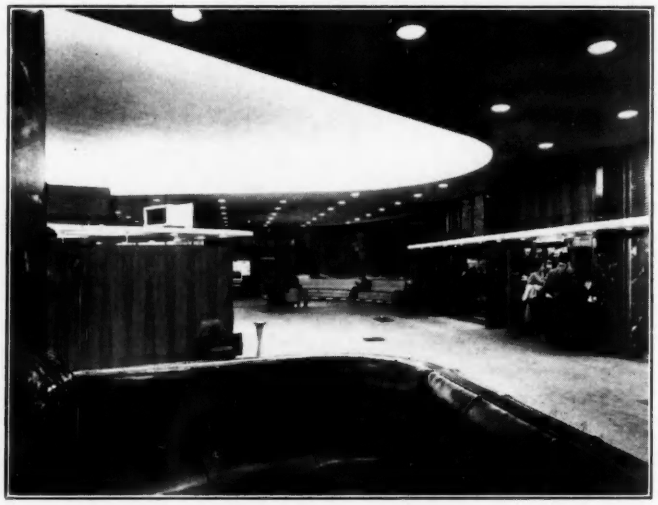


Fig. 6. Waiting hall showing bookstall (right), railway ticket office (left) and mural painting in the background.

ance, and, in order to avoid monotony by too much repetition of this treatment, Genoa marble, dark green with white markings is used as a contrasting material to emphasise the more structural features of the scheme. This material, which combines the advantage of serviceability with traditional aesthetic qualities, as well as forming an excellent foil in colour and texture, lines the principal doorway openings, the entrance lobbies and main columns.

The main portion of the hall is panelled in natural Honduras mahogany relieved in the surrounding recesses, with a rich Kevassinga. The East and West vestibules are encased throughout in straight grained elm with display cabinets inset into the walls in mahogany and grey warerite. Lighting to the vestibules is afforded by cold cathode tubes concealed behind the panelling, and by suspended canopies carrying tungsten and cathode lighting.

The lobbies giving access to and from the quayside and railway platform, are lined entirely in marble, the flooring being finished in a dove-grey terrazzo.

For the Telephone Hall, which is circular in shape and equipped with eight coin-operated call cabinets, natural teak was used in slat sections vertically from floor to ceiling. A feature of this facility is the circular seating which is covered in red hide. The adjacent Writing Room is panelled in weather sycamore, the writing tables being cantilevered on metal brackets from the wall.

In the Immigration Hall, the panelling is of Honduras mahogany, slat sections of the same wood being used to cover the radiussed walls. The ceiling is painted pale lime, while the flooring is in dove-grey linoleum. Console type desks and stools are provided for the Immigration staffs use, and these are of limed oak. The wall seating is covered in dark blue hide.

The Buffet, a feature of which is the double-serpentine shaped counter, Sailing Ticket Stand, Travel Agencies Stand and the Bookstall, are all finished in natural straight grained elm, with teak as a contrasting surface.

The flooring throughout the main portion of the accommodation is of ¼-in. thick linoleum tiles in a mountain grey shade relieved with random tiles in colours to echo the various finishing fabrics which have been used. All the divisional and entrance doors are of armourplate glass, hung in stainless steel and mahogany frames and fitted with specially designed handles of Bombay rosewood. Decorative metalwork generally is of satin chrome finish and silver bronze.

Heating is provided by an electrical system in the floor which makes use of thermostatically controlled cables, laid directly in the main floor screed, augmented as and when required by a re-circulating air trunking system located beneath the seating, the air being drawn up and out through the centre portion of the ceiling.

A comprehensive Sound Reproduction Installation operated from a Control Room in the Waiting Hall, includes facilities for the relaying of verbal announcements, radio reception or gramophone records.

An interesting feature is the large mural painting on the long curving wall at the North-west of the hall, the subject of which is based on the epic 16th century Portuguese poem, "The Lusiads" by Camoens. This tells the saga of Vasco da Gama's voyage of discovery around the Cape of Good Hope to India in the year 1497, the story being in pictorial form in colours to harmonise with those of the furnishing materials used in the hall.

A chart showing the route of Vasco da Gama's voyage to the East Indies, with by way of comparison, that of the track taken to-day by the Union-Castle Line's ships to the Cape, together with a brief explanatory description, is placed nearby the painting. The mural is by the well-known artist, John Hutton.

Acknowledgments

The Structural Steelwork Contractor for the work involved was Messrs. Fairfield Shipbuilding & Engineering Co. Ltd., whilst Messrs. West's Piling & Construction Co. were responsible for the piled foundations, and Messrs. W. E. Chivers & Sons Ltd., the pile caps and railway platforms. The building contract was undertaken by Messrs. Trollope & Colls Ltd., and Messrs. Heal's Contracts Ltd., the fitting-out and furnishing of the Waiting Hall.

The whole of the work was designed and erected under the supervision of the Docks Engineer, Mr. J. H. Jellett, O.B.E., M.A., M.I.C.E., for the British Transport Commission's Docks Management Board, with Mr. C. B. Dromgoole, L.R.I.B.A., as Chief Architectural Assistant, Messrs. Scott & Wilson, Kirkpatick and Partners as Consulting Structural Engineers, and Messrs. W. G. Edwards and A. Avery Hall, FF.R.I.C.S. as Quantity Surveyors for the building contract. The electrical work was carried out under the direction of Mr. E. S. Ely, M.I.Mech.E., M.I.E.E., Docks Mechanical and Electrical Engineer.

Further Terminal for Los Angeles

As a result of an agreement between the Board of Harbour Commissioners for Los Angeles and the American President Lines, Ltd., preliminary plans have been approved for the construction of a further combined passenger and cargo terminal. The agreement is subject to approval by the City Council. The terminal will be located on the west side of the main channel at berths 93-95, and will include a two-storey shed, 1,050-ft. long by 200-ft. wide with passenger facilities on the upper floor, and a one-storey cargo shed 630-ft. long by 200-ft. wide.

To serve the terminal and other shipping facilities to be built later in the area, a slip 1,200-ft. long by 400-ft. wide with a depth of 35-ft. alongside will be constructed in a nearby inlet. Extensive dredging is involved in the project. Facilities at the new terminal will also include a parking area capable of accommodating 3,000 cars, access roads, rail connections, refrigerated cargo space, latex tanks and other special features.

Ore Handling Installation at Narvik

Continuously Operating Belt Conveyor System

Introduction.

A large proportion of Sweden's iron ore output is mined in the extreme north of the country. The principal mining centres are at Kiruna and Malmberget, and the ore is transported overland—by rail—to the shipment ports of Narvik and Lulea, situated on the Atlantic and the Baltic respectively. The Norwegian port of Narvik is the more important of the two and handles about 75 per cent. of the ore produced by the mines, including virtually the entire output of those in the Kiruna district.

Narvik has an advantage over Lulea in that it is never icebound, even in the severest winters, thanks to the Gulf Stream which sweeps along the coast of Norway. Besides, it is only a little over a hundred miles distant from Kiruna. By 1951 the existing ore handling and loading plant at Narvik had become inadequate to deal efficiently with the 9 million tons of ore that passed annually through the port. The Luossavaara Kiirunavaara Aktiebolaget (LKAB Mining Company) accordingly decided to modernise and extend the installation.

Between 20 and 25 ore trains daily reach Narvik from the mines. Ten different grades of Kiruna ore, varying in iron and phosphorus content, are handled by the port. As it is not generally possible to synchronise the arrival of any particular grade of ore at the port with the available shipping facilities, the new installation had to provide for the stockpiling of fairly large quantities of each grade. A further requirement was that, in conveying the ore from the stockpile to the ship, it should be possible, if desired, to combine two grades in such proportions as to obtain a resultant mixture possessing a certain specified content of iron and phosphorus.

General Description of the Ore Handling Installation.

It was considered desirable that the existing ore handling plant should be integrated as far as possible with the new installation. The oldest part of the existing facilities, marked "A" in the accompanying key plan, dates from long before the war and consists of a quay equipped with chutes through which the ore arriving in railway wagons is tipped directly into the ship. The portion marked "B" is a newer installation, which was constructed by a Swedish firm after the war. It comprises a wagon-discharging and crushing plant (22) together with belt conveyors (27) for transporting the ore to the loading pier. The pier itself also belongs to this part of the installation and provides facilities for loading two ships simultaneously.

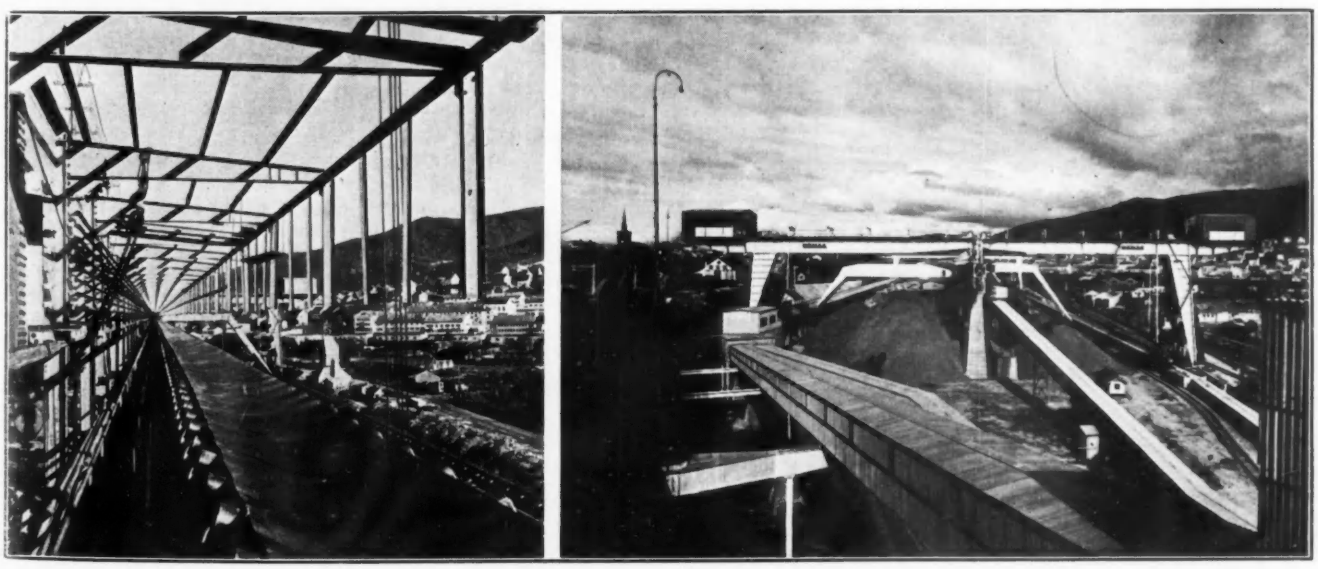
The site occupied by the new installation, which has been constructed by the German firm of Demag A.G., formerly served as a storage area for ore awaiting shipment. The stockpiled ore was reclaimed with the aid of travelling mechanical shovels and put back into railway wagons which conveyed it either to the discharging and crushing plant (22), or to the old loading quay (41), or to tipping shafts (42) which fed the ore to the pier conveyor system.

The new Demag installation had to incorporate the existing "B" installation and provide up-to-date facilities for handling 4,000 tons of incoming and 4,000 tons of outgoing ore per hour (i.e., stockpiling and reclaiming respectively). This represents an hourly handling capacity of 8,000 tons. In addition, it was necessary to be able to discharge 4,000 tons per hour direct from railway wagons to the "B" installation and thence to the ships. The storage yard was required to have a capacity of 2.4 million tons. A subsequent increase of this capacity to 3.5 million tons, by extending the yard, is envisaged.

The ore arriving by rail from the mines is taken to the unloading point (2), where it is fed through crushing plant and on to belt conveyors which take it directly to the main belt conveyor system of the "B" installation and thus to the loading pier. Alternatively the ore may be removed to the storage yard by means of belt conveyors which feed it to four travelling gantries provided with distributor belts. When a certain type of ore is required for shipment, it is taken from the appropriate stockpile by four grab-equipped travelling transporters and is transferred to the ship by way of a belt conveyor which discharges it on to the main conveyor system of the "B" installation.

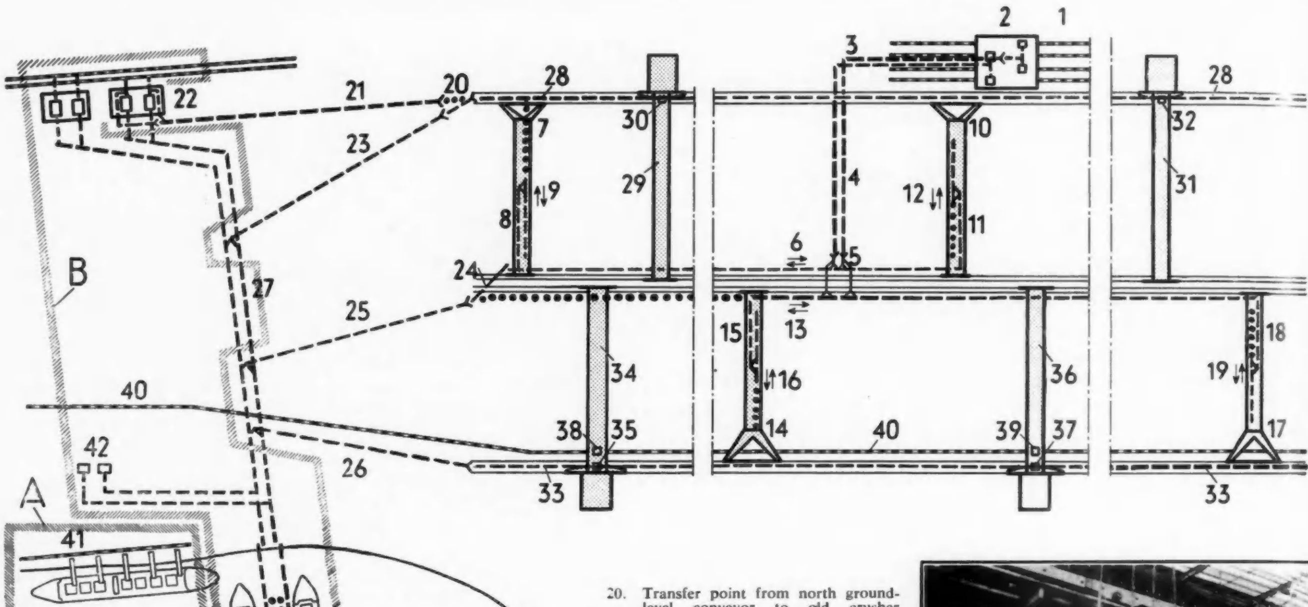
The principal feature of the new installation is the provision of a continuously-operating system of belt conveyors (with an overall length of 6.8 km.) working in conjunction with non-continuous materials handling by means of grab transporters.

An elevated conveyor bridge 800 m. in length runs the whole length of the storage yard, from east to west, dividing it into two halves. Each half of the yard is spanned by two distributor gantries and two reclaiming transporters. The gantries and transporters are semi-portal structures travelling on an upper track mounted on the conveyor bridge and on the lower track running along the north or south boundary of the yard. The distributor



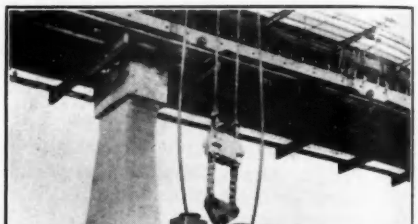
Left: Overload belt conveyors on central bridge. Roof of gallery not yet erected. Right: View from western end of new installation showing central bridge with transporters and distribution gantries.

Ore Handling Installation at Narvik—continued



Key Plan

1. Arrival tracks for ore wagons.
2. Unloading plant and crushers.
3. Rising conveyors.
4. Rising conveyors to central conveyor bridge.
5. Intermediate belt conveyors.
6. Mobile belt conveyor on the central bridge supplying the north distributor gantries.
7. North-west distributor gantry.
8. Fixed belt conveyor in gantry.
9. Mobile belt conveyor in gantry.
10. North-east distributor gantry.
11. Fixed belt conveyor in gantry.
12. Mobile belt conveyor in gantry.
13. Mobile belt conveyor on the central bridge supplying the south distributor gantries.
14. South-west distributor gantry.
15. Fixed belt conveyor in gantry.
16. Mobile belt conveyor in gantry.
17. South-east distributor gantry.
18. Fixed belt conveyor in gantry.
19. Mobile belt conveyor in gantry.
20. Transfer point from north ground-level conveyor to old crusher house (22) or to pier conveyors (27).
21. Belt conveyor to old crushing plant.
22. Old crusher house.
23. Conveyor feeding pier conveyors.
24. Intermediate belt conveyor.
25. Conveyor from central bridge to pier conveyors.
26. Conveyor from south ground-level conveyor to pier conveyors.
27. Pier belt conveyors.
28. North ground-level belt conveyors.
29. North-west transporter.
30. Receiving hopper.
31. North-east transporter.
32. Receiving hopper.
33. South ground-level belt conveyor.
34. South-west transporter.
35. Receiving hopper.
36. South-east transporter.
37. Receiving hopper.
38. Hopper for loading railway wagons.
39. Hopper for loading railway wagons.
40. Track to old pier.
41. Old loading quay with chutes.
42. Tipping shafts with belt conveyors for transferring ore from wagons to pier conveyors.



One of the grabs of 6 m^3 capacity.

gantries are so designed as to be able to pass underneath the transporters. The two types of travelling structure are thus able to move to any point along the length of the conveyor bridge without obstructing each other.

This installation permits the following handling operations to be carried out; from railway wagon to storage yard, from storage yard to loading pier; from railway wagon direct to loading pier; from storage yard to crushing plant and then to pier; from wagon to crushing plant and then to pier; from storage yard to old loading quay. For the last-mentioned operation the ore is loaded into wagons; in all other cases transport is effected by belt conveyors.

Operation of the Installation.

The ore trains arriving from Kiruna are passed through the unloading plant (2), which is able to deal with two wagons at a time on each of four tracks. When working at full capacity this plant can handle 4,000 tons of ore (the equivalent of about 110 wagon loads) per hour. This is a very high rate of performance, especially in winter, when the ore is frozen into large lumps which adhere firmly to the walls of the wagons. Special methods are employed for loosening the ore under such conditions, e.g., salt water sprays, flame throwers, pneumatic hammers, or wagon vibrators. From the wagons the ore is passed to four gyratory crushers which reduce it to lumps not exceeding 100 mm. in size. The crushed ore is collected in receiving bins which discharge it on to slat conveyors, and these in their turn feed it at a variable rate to the belt conveyor system (3). It is intended in the future to crush all the ore at the mines, so that the crushers at the port will have to be used only during the winter months to break up frozen lumps. In summer the flow of ore will bypass the crushers and be fed direct to the receiving bins under them.

The belt conveyors (3) discharge the ore on to the belt conveyors (4) which transport it to the overhead conveyors installed on the central bridge structure running the length of the storage yard. The conveyor systems (3) and (4), like most of the other conveyor systems of the installation, consist of a set of two independently driven parallel belts. In the event of a mechanical defect occurring in one of the conveyors of a set, the other can continue to perform its function.

A distributor system (5), consisting of chutes and short intermediate belt conveyors, feeds the ore brought up by the conveyors (4) to the conveyors (6) and (13) installed on the central bridge. From this point onwards the ore will follow different routes, according as it is intended for stockpiling in the yard or for direct loading into ships.

The overhead belt conveyors (6) and (13) are mobile on their bridge, the ends of these conveyors being connected to the travelling distributor gantries (7) and (10) over the north half of the yard and to the gantries (14) and (17) over the south half of the yard

Ore Handling Installation at Narvik—continued

Rear view of two transporters.

respectively. Two independent conveyor systems, U-shaped in plan, are thus formed, which can be moved along from east to west and vice versa. The distributor gantries of each system are a fixed distance apart (410 m.), this distance being equal to the length of the conveyor belts (6) and (13) respectively. Each of the gantries caters for a quarter of the storage yard area. To deposit ore in any particular part of the yard, the relevant gantry is moved into position, and the direction of travel of the overhead belt conveyor concerned—i.e. (6) or (13)—is appropriately adjusted so as to transport the ore to the gantry. In order to avoid tipping the ore all in one spot, each U-shaped system performs an automatic to-and-fro movement (in the east-west direction) between two fixed points. At the same time the distributor belts (9), (12), (16) and (19), with which the gantries are respectively equipped, move backwards and forwards, whilst their direction of travel can also be reversed. These arrangements ensure that the ore is distributed uniformly over a rectangular area of the yard. Each of the two distributing systems (viz., north and south) can handle 2,000 tons an hour.

For conveying the ore from the storage yard to the loading pier four travelling grab transporters (29), (31), (34) and (36) are provided. Each of these machines has an hourly handling capacity of 1,000 and is equipped with a 6 m³ Demag ore grab. These transporters have a lifting capacity of 35 tons, corresponding to the combined weight of the grab and its contents (approximately 18 tons of ore), and are moved along to any part of the yard where the ore to be shipped may be lying. The grabs discharge the ore into receiving hoppers which form an integral part of the supporting legs of the transporters. The hoppers are provided with top grates which retain any frozen lumps of ore, such lumps being subsequently broken up by lowering the grab on to them. From these hoppers the ore is discharged on to slat conveyors and fed to the belt conveyors (28) or (33) which run along the north and south boundaries of the storage yard. These conveyors are 754 m. and 797 m. in length respectively and are the longest in the whole installation.

The slat conveyors under the hoppers not only feed the ore continuously to the belt conveyors but they also perform the function of mixing the material. It often occurs that an ore of a certain composition is required for shipment. This composition is obtained by mixing two of the ten different grades of ore in a specified proportion, e.g., 70 per cent. of one grade and 30 per cent. of another. In that case each grade of ore is handled by one transporter. The speed of the slate conveyors can be adjusted so as to ensure that the correct proportion of each grade is fed from the transporters on to the belt conveyor (28) or (33). The actual mixing is effected on the belt conveyor.

The north and south belt conveyors (28) and (33) transport the ore from east to west. These conveyors are connected to the conveyor system of the older " B " installation by way of the belt conveyors (20), (23) and (26). Transfer of the ore to the pier conveyors (27) is effected by means of distributing chutes which can be so controlled that either of the two pier conveyors may be fed with a certain grade of ore. Roll crushers for breaking up frozen lumps are installed at these transfer points. The belt conveyors (27) transport the material to the loading pier, which provides simultaneous berthing accommodation for two vessels (of up to 25,000 tons on the seaward side of the pier). The ore is discharged into the ships' holds by means of swivelling jib loaders equipped with belt conveyors.

As an alternative to the above procedure, the ore can be conveyed direct from the railway wagons to the ship. In that case it travels on belt conveyors from the unloading plant (2) to the pier conveyors (27). By this means 4,000 tons of ore per hour can likewise be handled. Half of this amount is transported via the conveyors (24) and (25). The other half is dealt with by the distributor gantry (7), which is made to discharge its load into the receiving hopper of the transporter (29), the latter being placed directly over the gantry. The ore is then handled by the conveyors (28), (20) and (23).

Other variants are possible. These have been indicated in the previous section of this article.

Details of the Installation.

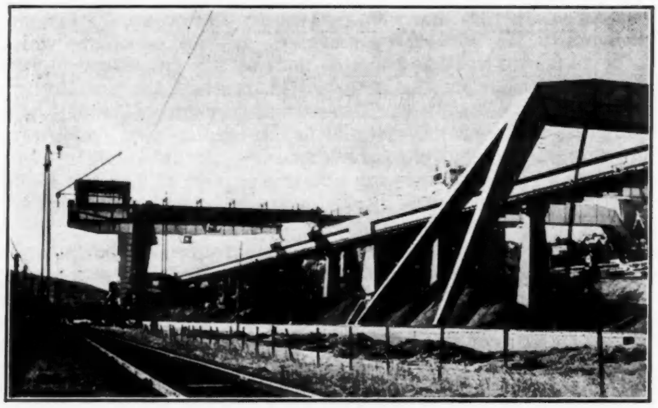
The unloading plant (2) consists of a covered shed over a 20 m. deep underground chamber containing the crushers and ancillary equipment. The bottom-dump ore wagons are moved into position over openings between the rails and discharge their contents through these openings into receiving hoppers. From these hoppers the ore is passed to roller grates with power-driven rollers which feed it to four gyratory crushers and which at the same time act as a screening device permitting the smaller lumps to bypass the crushers. Each crusher has a capacity of 1,000 tons per hour and is driven by a 165 kW squirrel-cage motor through a fluid starter coupling and gearing. In the event of overloading of a crusher, the rollers of the feeding grates are stopped by an electrical safety device. When the load returns to normal, the rollers are restarted automatically.

The ore that passes through the roller grates or is discharged from the crushers is collected in bins. From these it is drawn off by slat conveyors which feed it to a pair of belt conveyors (3). The latter are installed in an inclined tunnel rising at an angle of 18°.

These conveyors, like all the others in the installation, consist of 1,200 mm. wide rubber belts which are driven at a speed of 1.7 m./sec. and have a conveying capacity of 2,000 tons per hour. The belts are in all cases driven by 380-volt three-phase squirrel-cage motors fitted with an electromagnetic coupling which permits

View of transporter, showing engine house and grab. Loading pier in background.

Ore Handling Installation at Narvik—continued



View of storage yard with central conveyor bridge, showing two transporters in the background and distribution gantry in the foreground.

the motor to start under zero load and attain its normal running speed. The load is then applied as a gradually increasing torque, so that the belt is gently and smoothly set in motion and high starting currents are avoided. The very long belt conveyors (28), (33), (6) and (13) are driven from both ends. The overhead conveyor systems (6) and (13) are mobile in the sense that they can be moved in either direction along the central bridge; in addition, each system as a whole performs a to-and-fro movement at a speed of 7.5 m./min.

The transfer of material from one belt conveyor to another is in most cases effected by means of chutes lined with manganese steel plates. At transfer points where two different conveyors have to be fed by the same chute, the latter is equipped with a hydraulically operated swivelling discharge gate.

All the belt drives, swivelling gates and mobile conveyor systems are operated from a central control desk. The conveyors are housed in covered galleries to protect them from the weather.

Each distributor gantry contains two belt conveyors, one of which is fixed, whilst the other is mobile and reversible. The mobile conveyors help to distribute the ore uniformly, as described in the previous section. These gantries, to which the 410 m. long overhead conveyors are permanently attached, perform a to-and-fro movement (7.5 m./min.) when stockpiling the ore; in addition, they can travel along the yard at a speed of 22.5 m./min. These movements are effected by driving units installed on the upper and lower supports of the gantries and furthermore by units mounted on the mobile frames of the overhead conveyors (6) and (13). Each distributor gantry is provided with an operator's cabin from which the movements of the various conveyors and of the system as a whole are controlled in accordance with instructions received by telephone from the central control station.

The transporters are provided with a rope-hauled trolley, the heavy driving machinery being installed in an engine house on the cantilevered end of the horizontal girder. The grab is operated by means of three winch drums, for hoisting, grabbing and travelling respectively. The engine house also contains a Ward-Leonard convertor set consisting of a three-phase 3,000-volt driving motor, of 570 kW capacity, and two 440-volt direct-current generators. One generator feeds the hoist motor, whilst the other feeds either the grabbing or the trolley travelling motor, at the operator's choice. The Ward-Leonard system provides a wide range of loss-free speed control. It is augmented by an amplidyne system which permits quicker operation and the use of lighter switchgear.

The control cabin is attached to the horizontal girder of the transporter and gives the operator an unobstructed view of the yard and the receiving hopper. His task is facilitated by the provision of limit switches for the hoisting and travelling movements of the grab and for the movement of the transporter itself. He can thus concentrate on manipulating the grab. All the various operations are controlled by means of only two levers.

The travelling movement of the transporter down the length of the storage yard is effected by two independent driving units which actuate running wheels at the upper support (on the central conveyor bridge) and lower support (at ground level) respectively.

A special automatic breaking device prevents accidental movement of the transporter due to strong winds or to the fact that the transporter tracks are on a gradient of 1:100.

The distributor gantries pass underneath the transporters. Various safety devices (incorporating limit switches, etc.) are provided with a view to preventing collisions between a gantry and the grab bucket of a transporter or collisions between transporters.

The transporters have a clear height of 29 m. and a span of 51.25 m., the trolley track being 42 m. in length. The hoisting speed is 73.5 m./min. The travelling speed of the trolley is 146 m./min. and that of the transporter itself is 30 m./min. A lifting capacity of 35 tons (grab + load) is provided.

The central control station is situated at the top of a concrete building in the middle of the storage yard. The operator sits at a control desk facing an illuminated mock-up layout of the installation. The route to be travelled by the ore is determined by the actuation of selector switches which set the swivelling discharge gates of the chutes at the transfer points in the appropriate position. Flashing signal lights give warning of defective operation of any part of the installation. The selector switches are fitted with safety devices eliminating the risk of wrong connections which could cause overloading of a conveyor system.

Correspondence

O.E.E.C. Conference on Port Productivity

Dear Sir,

In an Editorial Comment under the above title in the current issue of your Journal you express the opinion that the statement adopted at the O.E.E.C. conference was "in startling variance to the traditional policy followed by dock labour organisations."

As nearly all the dockers' representatives at the O.E.E.C conference came from dockers' unions affiliated with the International Transport Workers' Federation and attended under its leadership, I feel obliged to make the following observations.

Whenever the Dockers' Section of the I.T.F. has discussed the mechanisation of dock work and related problems, the attitude adopted towards it has been constructive. For instance, in reports of the Section to two successive Biennial Congresses of the Federation (London 1954 and Vienna 1956) it was stated that "the attitude of the Section towards the mechanisation of dock work has been favourable, in so far as it is calculated to lighten work and to increase productivity, and not to deprive dockers of their livelihood." This, surely, is very different from your remark that "hitherto port workers in all parts of the world have been strongly opposed to the introduction of mechanised equipment on the grounds that redundancy and unemployment would result."

It is just not true that our dockers' unions oppose mechanisation or any measure to increase the productivity of the industry "on the grounds" that it means redundancy, etc. As a general trade union principle they were—and still are—opposed to measures which entail hardship to the workers of an industry. They oppose them because such consequences are incompatible with the very purpose of mechanisation, automation, etc., which is to increase the well-being of all sections of the community, including the workers.

The sense of the Copenhagen statement was that increased productivity is desirable, that the primary role in achieving it falls upon those responsible for planning and organising the industry and that the workers concerned want to make a constructive contribution towards it in so far as they are able to and allowed to.

Yours faithfully,

O. BECU,
General Secretary.

International Transport Workers' Federation,
Maritime House,
London, S.W.4.
27th November, 1957.

Sea Conditions at Tema Harbour

Analysis of Wave Recorder Observations

By J. DARBYSHIRE, M.Sc. (The National Institute of Oceanography, Wormley, Surrey).

For some time, work has been in progress on the construction of a new harbour at Tema, Ghana. The consulting engineers, Sir William Halcrow and Partners, required accurate information about the wave heights and lengths usually experienced near this coast and accordingly a wave recorder was laid on the sea bed at a depth of 53-ft. The instrument had been designed by Valembois of Chatou, France, the wave pressure being converted by a suitable device into an electrical output which is recorded by a galvanometer with a light scale, the deflections being photographed on 35 mm. film. This instrument is self-contained, having no electrical connection with the shore, and derives its power supply from batteries. After working for two to three weeks, the instrument is raised up and the film processed. There is a time switch in the recorder which switches it on for about 30 minutes at two hour intervals. There is also a relay which automatically switches the instrument on when the waves exceed a given height. Waves were recorded for a short time in October, 1955, and then almost continuously from April, 1956, to February, 1957. After this time some instrumental troubles developed but recording recommenced in July, 1957, and has continued since.

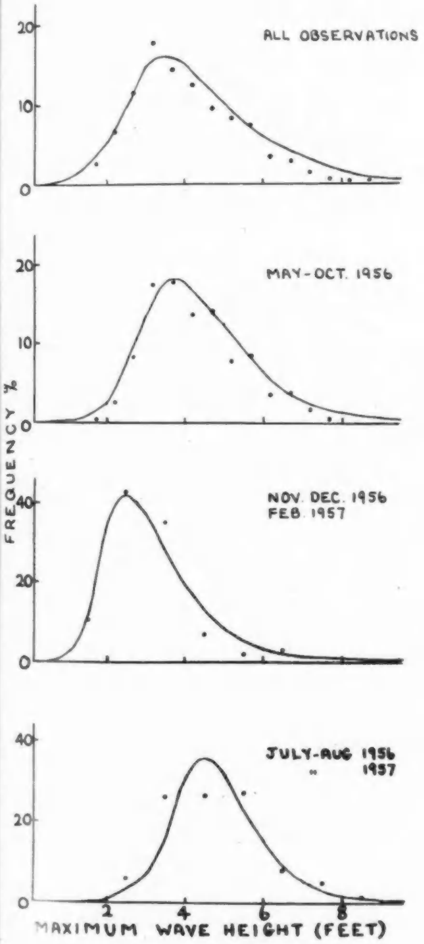


Fig. 1. Frequency of occurrence of values of maximum wave height against value of maximum wave height.

Distribution of Wave Heights

In a previous paper (1956), some curves were given for the distribution of wave heights in the North Atlantic, Perranporth in Cornwall and Casablanca. It was proposed to prepare similar curves for Tema. There was some difficulty as a complete year of observations was not available but all the observations were plotted together and also divided into seasons and plotted. The results are shown in Fig. 1. If y is the probability that the maximum wave height of the waves lies between $x-\frac{1}{2}$ and $x+\frac{1}{2}$ ft., expressed as a percentage, then the corresponding formulae are:—

For all observations

$$y=32\exp-(\log x-\log 3.5)^2/0.3$$

For May to October, 1956

$$y=36\exp-(\log x-\log 3.8)^2/0.2$$

For November, 1956—February, 1957

$$y=42\exp-(\log x-\log 2.5)^2/0.3$$

For July—August, 1956
and July—August, 1957

$$y=36\exp-(\log x-\log 4.5)^2/0.1$$

These formulae are similar to those used in the previous paper and considering that the number of observations are fewer in this case, agreement with the distribution curves is not unsatisfactory.

Location of Wave Generating Area

An examination of the curves shows that the heights tend to be greater during the July—August period which corresponds to the southern winter. The coast near Tema is much more exposed to swell proceeding from the south-west from the South Atlantic Ocean than to swell from the North Atlantic. The wave period is usually between 10 and 16 secs. Some of the wave records for June 7, 1956, were frequently analysed as described by Barber, Ursell, Darbyshire and Tucker (1946), in Fig. 2. The results give a plot of wave activity against wave period, and indicate that the period of maximum activity decreases very slowly. It is possible to calculate from this rate of decrease, the distance of the wave generating area from Tema. An estimate based on wave spectra shown is 5,000 miles. The generating area would thus be between latitudes 50°S and 60°S. As this set of spectra is typical of many others, it can be inferred that most of the wave activity originates from these latitudes.

Long Waves or Surges at Tema

Since the wave recorder was first used, tests on a model of the harbour carried out at the Hydraulics Research Laboratory at Wallingford showed that a surge or long wave of about 2 to 3 minutes' period and over 12-in. height could be troublesome, ships being knocked against each other or against the dock sides. It was therefore important to determine whether such

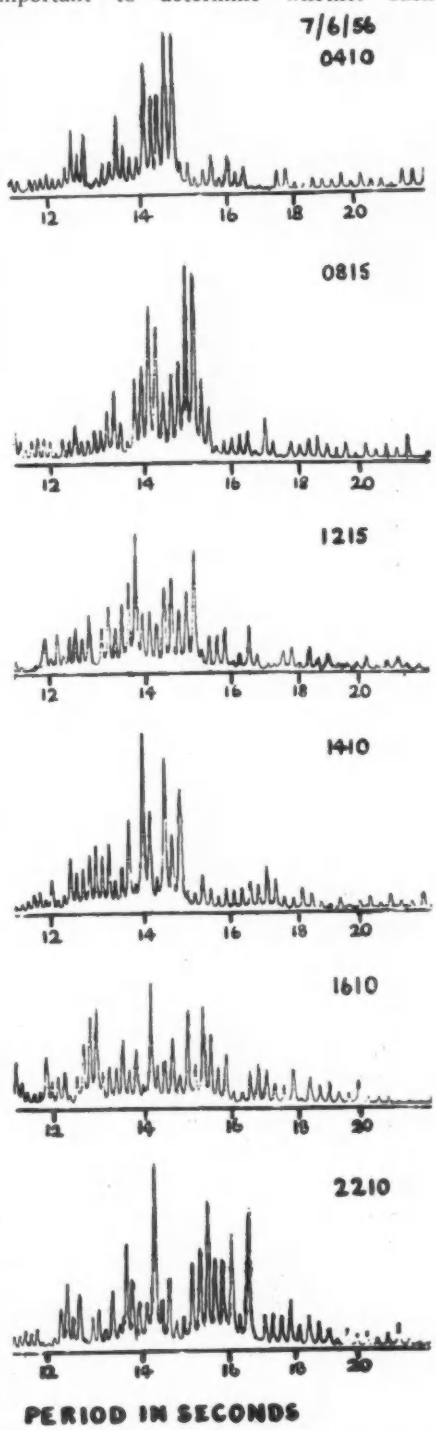


Fig. 2. Wave frequency spectra, Tema, 7th June, 1956.

Sea Conditions at Tema Harbour—continued

surges could actually occur and as there was no long wave recorder at Tema, any evidence of their existence had to be found from the ordinary wave records. The wave records were magnified optically and values of wave pressure read at 2 sec. intervals for the whole length of a 30 minute record. Averaging was carried out over 30 second intervals centred round each 2 sec. value to obtain a running mean. When these means were plotted against the time, it was apparent that there was still some ordinary wave by Tucker (1950) at Perranporth, Cornwall, which was 1/12. Long waves could possibly be due to the deformation in shape of ordinary waves when entering shallow water, the crests tending to rise to a higher level above mean sea level than the troughs fall below it. This effect would also, theoretically, lead to a square law relationship but this might be modified by conditions not allowed for in the classical theory. Tucker found that the long waves were mainly due to the acceleration of water must be attributed to the deformation of the wave shape or possibly to the non-linearity of the recorder. The deformation in shape can be worked out for the depth of measurement on the basis of the classical hydrodynamical theory. It is found that for the highest wave heights considered, 5—8-ft. and a period of 12 secs., this effect accounts for from a third to a half of the long wave height but this proportion diminishes as the heights get less because of the square relationship.

Fig. 3. Plot of long wave height against ordinary wave height.

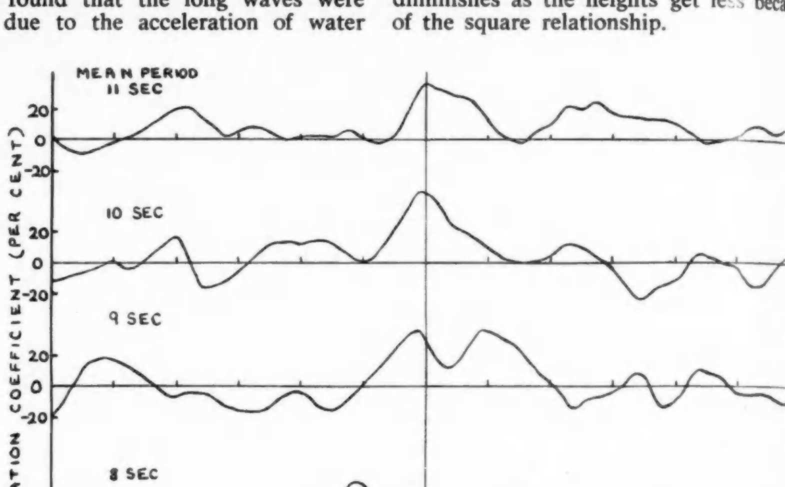


Fig. 4. Cross-correlograms of long waves and envelopes of ordinary waves.

activity left and this was removed by smoothing by eye, leaving a record of the long waves. The maximum long wave height is compared with the maximum ordinary wave height in Fig. 3. These results are reliable only if the instrumental response is linear enough for any rectification effects to be negligible, but if the response is sensibly independent of period over the range in question (1 to 10 mins.), estimates of the long wave heights would at any rate be always on the high side and would be useful for safety considerations. The effect of non-linearity of the instrument, would, however, tend to establish a relation where the long wave height is proportional to the square of the ordinary wave height but Fig. 3 shows an approximately linear relationship, the long wave height being about 1/20 of the ordinary wave height. This then suggests that the long waves are not spurious. The maximum wave height obtained during the time the wave recorder has been used is 8-ft. and so judging by Fig. 3, the maximum long wave height that could be expected is 5-in. which is below the danger level. The long wave periods varied from 1 to 10 minutes, the maximum activity being usually between 2 and 4 minutes' period. The relation of 1/20 between long wave and ordinary wave height is of the same order as that obtained towards the beach when it is transported by the waves. In this case, as Tucker found, the long waves would tie up with the ordinary waves which passed the recorder about five minutes earlier, as this time is just right for the waves to reach the shore from the position of recording and for the long waves to return. This result was obtained by cross-correlating the long waves with the envelope of the ordinary waves at different times, and in the Perranporth case there was very little correlation at coincidence, implying that the effect of deformation of wave shape was small. Similar cross-correlograms were obtained for Tema and are shown in Fig. 4. The distance of the wave recorder from the shore was 3,500-ft., which is approximately the same as the distance at Perranporth. The first correlogram is a mean of three taken during the same day and when the wave period was nearly constant. There does appear to be an increase in correlation when the long waves lag about 4—5 minutes behind the ordinary waves, and although in each single example, this rise in correlation is not significant above the general background, the lag tends to increase from example to example with diminishing period as would be expected. There is also on all the examples an appreciable correlation at coincidence which

Conclusions

The maximum wave heights at Tema follows a frequency distribution of a similar form to that found to apply at other places. The heights tend to be a maximum at about July and August, corresponding to the southern winter period. Frequency analysis confirms that the waves are generated in the Southern Ocean. There is some evidence for the existence of long waves or surges which may reach a height of 5-in. These waves could be caused partly by the deformation of the shape of ordinary gravity waves as they enter shallow water and also partly due to the acceleration of water transported towards the shore as found by Tucker.

Acknowledgments

The author wishes to thank his colleagues at the National Institute of Oceanography for advice and assistance in preparing the paper. He also wishes to thank Sir William Halcrow and Partners and the General Manager of Ghana Railways for the use of the wave recorder.

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The Reconstruction of Two Jetty Approaches

Improvements to Purfleet Terminal

By A. G. TATE, B.Sc.(Eng.), A.M.I.C.E., A.M.I.Struct.E.

Synopsis

THIS article describes the reconstruction of the approaches to numbers 1 and 2 jetties at the Esso Petroleum Company's Terminal at Purfleet, Essex, on the River Thames.

Factors leading to the adoption of the proposed scheme are discussed together with the problems overcome during the course of the constructional work.

Introduction

Purfleet Terminal is used as a distribution centre for the Company's oil and petroleum products by road and also by barge to the upper reaches of the Thames. The products are delivered to the Terminal by vessels of up to 28,000 tons deadweight which are discharged at the jetties through pipe lines into bulk storage. The products can be pumped from storage to the barge berth jetty where the barges are loaded ready for distribution.

Fig. 1 shows the original layout of the jetties and barge berths.

Prior to the reconstruction, the jetty heads and their approaches were of timber construction and by 1948 it was apparent that a large annual expenditure would be necessary to maintain the approaches in good condition. There was prominent decay in many of the members of the approaches and also damages sustained by the structures by virtue of small vessels using the barge berths were of regular occurrence.

A further adverse factor was the continual siltation of the barge berths, which, it was considered, would be prevented by allowing an unobstructed flow of tide between the approaches which was not afforded by the existing construction.

In view of the foregoing, it was decided to proceed with the reconstruction of the two approaches.

General Design Considerations.

It was essential that the pipe lines on the existing approaches were maintained during the constructional work so as not to interfere with the normal functioning of the Terminal. A further consideration was that the heavy congestion of pipes on the sloping river bank made it necessary that any heavy constructional plant and materials would have to be delivered by water.

Consideration was given to various alternative forms of construction and it was decided to form the new approaches of steel bridge spans supported on suitable abutments.

The clear span between the rear faces of the jetty heads and the barge berth jetty was 152-ft. 10-in. and it was arranged to bridge this length with two spans carried on three pairs of abutments. It was evident that in view of the volume of small vessels using the barge berth jetty they would have to be of substantial construction in order to withstand the impacts that were bound to occur. It was decided to form these abutments in steel piling filled with mass concrete. In view of the soft alluvial deposits underlying the river bed it was necessary to found the abutments on reinforced concrete bearing piles.

The central pair of abutments were made cut-water in plan but it was considered that if this shape were adopted for the ends pairs of abutments there would be a real risk of the stems of small craft becoming lodged between the splay faces of the abutments and the faces of the main and barge berth jetties. For this reason, the end abutments were made rectangular in plan.

Each rectangular abutment was founded on five 35-ft. long by 12-in. square reinforced concrete piles and the cut-water abutments on four 35-ft. long by 12-in. square reinforced concrete piles.

The steel sheet piling was Frodingham No. 3 section in 52-ft. lengths, all special corner piles being riveted.

Each abutment was completed by the addition of 12-in. square Douglas Fir horizontal walings bolted to the piling at six levels with 6-in. by 12-in. vertical Greenheart close sheeting coach-screwed to the walings. Bull-head rail mooring travellers with rings were fitted to the abutments.

The barge berth jetty to shore spans were bridged with two unequal spans. The pair of abutments common to these two spans were formed of reinforced concrete piers founded on bored piles and the shore abutment at the top of the river bank consisted of a reinforced concrete wall also founded on bored piles. This wall also formed a part of the general scheme for raising the level of the river bank made necessary by the disastrous floods of February, 1953.

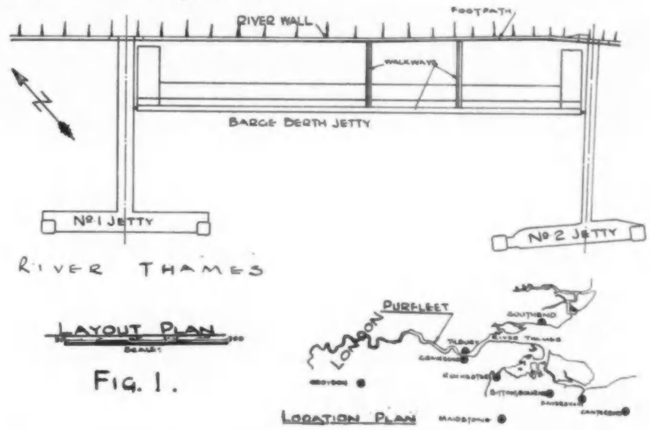


Fig. 1.

The reason for using bored piles in these abutments was due to the fact that the situation of the piles on an already congested site made the use of the equipment necessary to drive precast piles impracticable.

The general details of the scheme are shown in Fig. 2.

From this figure it will be seen that the bridge spans have two walkways carried on the top and bottom transverse members which also carry the pipe runs. The spans are designed to carry normal pedestrian loading and also small trolleys carrying ships' stores. There is provision for the addition of considerable further pipework to cater for future developments.

Each span is given an upward camber of sufficient magnitude that the spans become horizontal under maximum combined dead and live loading.

The ends of each span are fitted with pin and roller bearings to facilitate expansion and also to prevent berthing blows from tankers using the jetty heads from being transmitted through the approaches.

Suitable lighting has been provided to each approach.

Construction

The scheme described was carried out as two separate contracts. The first contract consisted of the reconstruction of the approaches between the two jetty heads and the barge berth jetty. The second contract, which was carried out a short time after the completion of the first stage, consisted of the completion of the two approaches back to the river bank.

Before the main constructional work could proceed a certain amount of the existing approach to Number 1 jetty had to be stripped on the down river side to obtain the necessary clearance for the driving of the sheet piles to the new abutments. Great care had to be taken during this operation so as not to endanger the support to the pipe runs.

In order to drive the piling, floating equipment was used and it was decided to drive the sheet piles with a double-acting steam

The Reconstruction of Two Jetty Approaches—continued

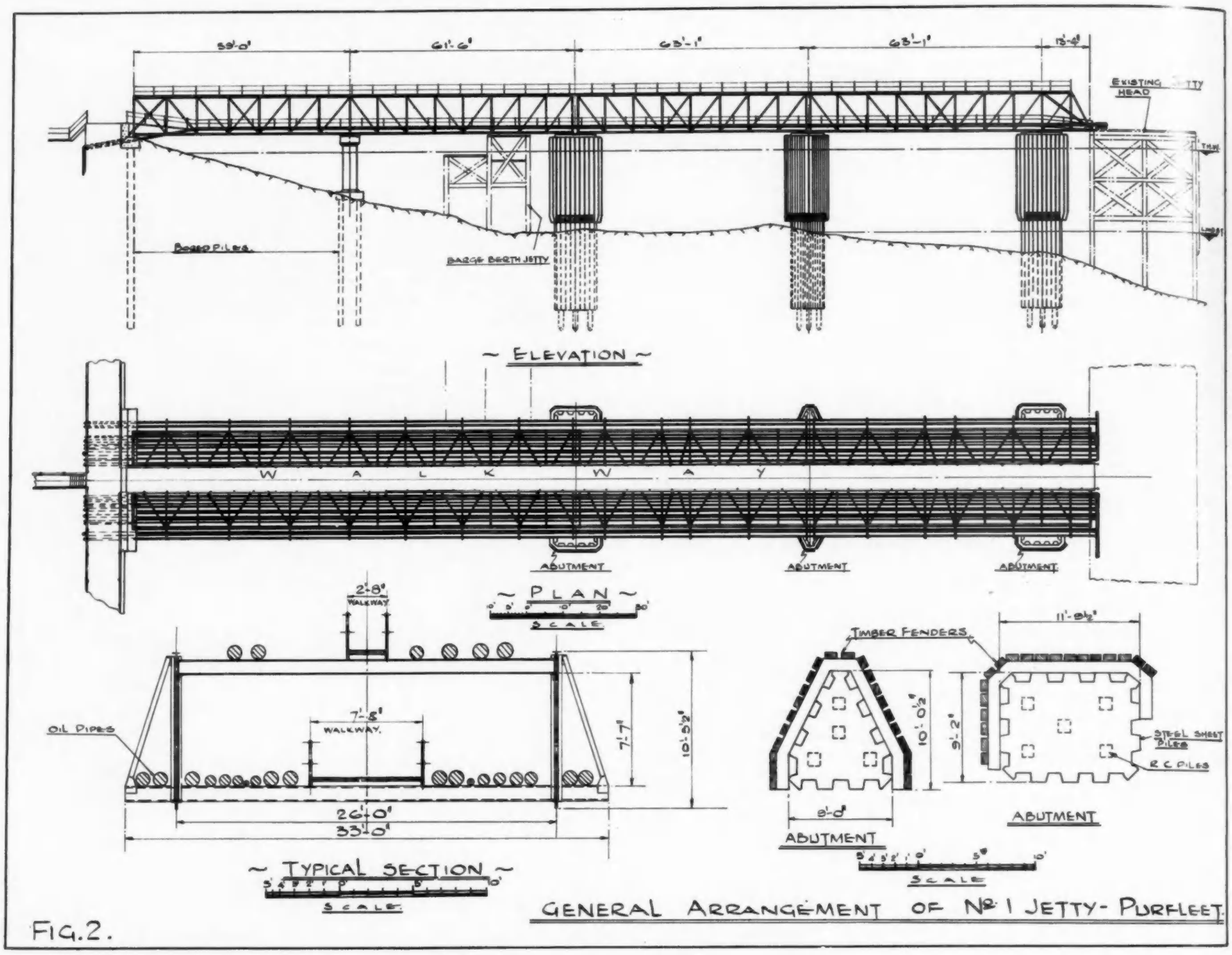


FIG. 2. GENERAL ARRANGEMENT OF No. 1 JETTY—PURFLEET

hammer. In view of the fire risk at the Terminal the use of a boiler was not permitted and the necessary steam required to operate the hammer was supplied through a long run of steam flex which was laid from the client's own boiler house which was situated outside the fire zone.

All of the sheet and bearing piles were brought to the site by barge in which they were kept until required for driving.

The following procedure was adopted for the driving of the piles to the abutments.

First of all, the inside lines of the sheet piles were driven. Next, the reinforced concrete bearing piles were driven with a drop hammer operated from a diesel winch to the required set. Finally, the remainder of the sheet piling to each abutment was pitched until closure was effected when they were driven to final penetration.

Upon completion of the piling, any soft material that had accumulated within the area enclosed by the sheet piles was removed by grab before the filling with concrete was commenced. The concrete fill was pumped to the abutments from a pump situated within the area of the Terminal and immediately behind the river bank. During this operation, the sheet piling was suitably stiffened to prevent distortion. The top of the concrete was boxed out for the later addition of the bridge bearings.

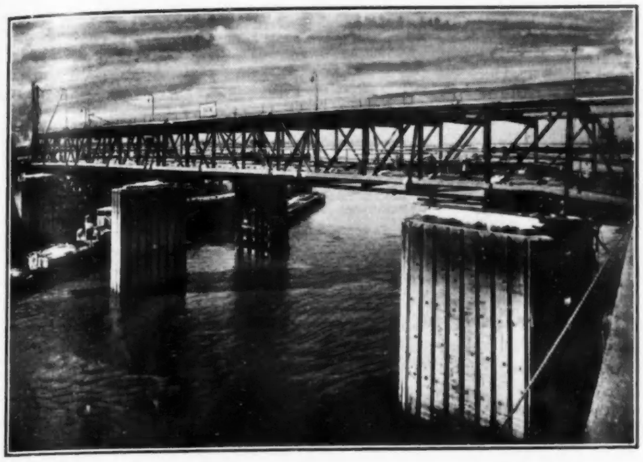
The bridge trusses and ancillary steelwork was fabricated off the site and were, as in the case of the piles, transported by barge. The unloading of the trusses and their placing upon the abutments presented a special problem. The weight of the trusses was not great and the main requirement of the crane to be used for unloading and placing was sufficient jib length to

Placing the bridge trusses to No. 1 Jetty Approach.

enable the spans to be lifted from the dumb barge and placed on the side of the approach remote from the position of the crane. It became evident that the only plant that would fulfil these requirements was one of the floating heavy lift cranes owned by the Port of London Authority.

It was fortunate that such a crane was available at the time

Reconstruction of Two Jetty Approaches—continued



A view of part of the completed approach to No. 1 Jetty.

in Tilbury Dock, only a few miles from the site and with this equipment it proved possible to lift and place the trusses of each jetty head to barge berth jetty section of the approach in one tide.

After placing, the trusses were temporarily strutted and the end bearings fixed and grouted into the pockets left in the concrete of each abutment.

The pipe lines were then broken in sections and jacked up slightly to enable the steel cross members to be inserted between the timber decking of the old approach and the undersides of the pipes. As soon as the cross members had been secured and the pipe supports fixed, the pipes were lowered back into place.

The approach spans were completed by the fixing of the sway bracing and outriggers and also the timber decking, handrailing and lamp standards.

Simultaneously with this work, the protective timbering was fixed to each of the abutments.

The final operations consisted of stripping down the timbering of the old approaches and extracting the piles, during the course of which work considerable difficulties were encountered.

Some months after the completion of the work described, work was commenced on the reconstruction of the barge berth jetty to river bank section of the approaches. The first operations entailed the sinking of the bored piles and the construction of the reinforced concrete piers and the reinforced concrete abutments at the top of the river bank. Thereafter, the placing of the approach spans and construction followed generally upon the lines described above.

The work described was commenced in September, 1953, and completed in March, 1955, at a total cost of approximately £100,000. It was carried out by G. Tate & Son Ltd.

It was mentioned in the introduction that prior to the reconstruction, siltation of the barge berths was of continual occurrence. Since the completion of the work there has been no recurrence of this problem.

Acknowledgment

The Author wishes to thank the Esso Petroleum Company Limited for kindly granting him permission to publish this article.

Mechanical Handling at the Port of Singapore

Review of Post-War Developments

By W. H. LAIT, M.Inst.T.

In 1945, at the end of the Japanese occupation of Singapore, innumerable problems faced the Singapore Harbour Board. It was found that approximately 75 per cent. of the dock sheds, both transit and storage, had been destroyed by incendiary bombing. The rail tracks, roads and wharf aprons were all in a very bad condition and perhaps the only saving grace was that practically all sea walls were intact and in good order.

The whole of the plant, gear and working equipment, which had consisted of cranes, sheerlegs, locomotives, railway wagons, hand trucks, trolleys, bogies, etc., was either missing or only a small percentage of the original stocks remained and that which remained was left in a very bad condition.

It was only by taking over from the Military Authorities the gear they had brought on to the island, such as cranes, trailers, cargo slings, etc., and by the manufacture of some 1,200 hand trucks by the Board's Dockyard Department that an initial start to normal port working was made possible.

Nothing was left of the documentation and records system that had been in use prior to enemy occupation with the exception of a few day books, ledgers, etc. It was necessary, therefore, to have some scores of documents redrafted and printed, most of which were compiled mainly from memory.

The general scene was one of chaos, which was enhanced by the acute shortage of clerical and administrative staff. The majority of the former were in bad health and the latter were mostly new and inexperienced.

Post-War Rehabilitation.

At the beginning of the process of rehabilitation, temporary sheds were constructed using the little material that was available. Although inadequate for the covered storage required the temporary structures helped to bridge the gap until steel supplies permitted new permanent sheds to be erected. The new sheds are of approximately 400-ft. x 100-ft., with floors uninterrupted by supporting columns. Wharf aprons and roadways were made up and rail tracks repaired, revised and countersunk, offering clear and smooth ground levels. Open storage areas behind the berths were constructed of hard standing. Locomotives and rolling stock, berthing and salvage tugs, fire fighting equipment and fire stations were repaired, built or purchased. Both senior and junior staff were trained and gradually built up to the required standard. It will be appreciated that all this progress was repeatedly hampered and often retarded by the prevailing conditions.

Practically from the time the British Military Administration handed over to the Civil Authorities on 1st April, 1946, the Board proceeded to plan for the mechanisation of cargo handling operations. Everything pointed to the necessity of this step, the main factors being the poor physical state of the labour, the need to keep pace with modern methods and to bring the port back to its pre-war efficiency.

Firstly it should be explained that the pre-war method of engaging labour was by contract, the men being obtained from three principal contractors who supplied labour for all operations. Apart from mobile cranes and other miscellaneous gear, cargo was handled manually on the wharf aprons and transported to and from the sheds by hand trucks or sack barrows whilst the longer distances were dealt with by the Board's railway system. Shortly after the re-occupation, the Board successfully negotiated with these contractors and took the whole labour force onto its books in direct employment. This necessitated the opening of a labour office and pay offices at strategic points and the whole paraphernalia of records, timekeeping, pay sheets, service record cards each in duplicate with a photograph of the employee for security purposes, and the engagement and training of the necessary administrative and supervisory staff. The labour is housed, fed and paid by the Board, daily, in the case of casual labour and weekly in the case of permanent labour, the latter enjoying a minimum guaranteed wage, or, to use the Chinese expression, a guaranteed minimum number of Kungs or working periods per week. The numerical strength of the labour force at that time was approximately 4,500, made up of half Chinese, half Indians from the Middle Pro-

Mechanical Handling at the Port of Singapore—continued

vinces of India and a sprinkling of Malays. The head of the labour office now ranks as a deputy to the Traffic Manager. A Welfare Department was instituted with a Welfare Manager and appropriate assistants who supervise the feeding of the whole labour force with two meals each day. This department is also responsible for the housing of the labour, in blocks of flats built by the Board. Conditions were improved and a bonus scheme introduced for the training of Serangs and Mandores which constitute the leaders or foremen of each gang.

The Board's Bye-Laws stipulate that all labour working a ship with certain exceptions, must be supplied by the Board and the system is to supply separate gangs, including winchmen and signalmen, on board, and on the wharf. To illustrate this, if a ship discharged 6 hooks on to the wharf she would order 6 gangs on board and 6 gangs on wharf but if 3 of these hooks were working overside the order would be 6 gangs on board and 3 gangs on the wharf. Practically all lighterage companies supply their own labour to work within the lighter.

The manning scale for a gang on board was 12 plus 1 Serang, 2 winchmen and 2 signalmen and for a gang on the wharf 1 Mondore plus 19 men. With the standards known in this country the manning scale would probably be considered excessive but it must be remembered that the labour force, made up entirely of Asian labour, physically handled every package in the ship's hold, on the wharf and in the sheds, stacking twenty bags high. The actual operation of loading and discharging is effected by the ships' gear and derricks.

Much has been written on the subject of wharf cranes versus ships' gear, but in Singapore it has always been believed to be uneconomic to supply cranes which, particularly with modern ships, duplicate the provision of very fine equipment. At the same time, before the war, one or two wharf cranes were available but were only used to expedite the heaviest hatch, as of course, this is generally the controlling time factor for a ship's completion.

Mechanical Handling Equipment

Apart from one or two odd items the Board's initial purchase of materials handling equipment was 40 low elevating battery platform trucks, worked in conjunction with stillages. The purchase was, in actual fact, the nursery stage of an operation which in due time was to materialise into 100 per cent. mechanisation.

To facilitate the working of these trucks, records of wharf gangs kept in the labour office were rearranged. Members of each gang were numbered 1 to 20 and, on paper, formed into two halves, the foreman heading the first half and bearing the number 1 and the assistant foreman heading the second half bearing the number 11. This kept each gang intact, the object being to provide the facility of splitting a gang of twenty men, known as a trucking gang, into two gangs of 10 men each known as mechanical gangs and each with its own supervisor. This was practised when gangs worked with platform trucks and whenever possible the two halves of any gang worked at adjacent hooks or at least with the same ship.

During this traditional period a tonnage bonus scheme was introduced by the Board which was paid in addition to the day working rate. It was designed on a comprehensive basis and not by commodities, as it was felt that the latter would tend to attract labour to those items of cargo offering a quicker working rate, and although work was detailed by roster, absenteeism prevailed with the unpopular cargoes. Payment was calculated on a percentage of the day-time rate on a sliding scale increased by ½ tons on the working rate, and the result of each day's work was made known to the labour force by posting on notice boards in the labour offices not later than noon the following day.

It was also at this time that the Board stopped recruiting labour for wharf gangs. With labour of this type there is always a natural drift, particularly when other industries offer an incentive to migrate, as most labour on rubber estates, tin mines, public works department, municipality, etc., is of the unskilled type and the removal of a man's domestic possessions offers practically no problem at all. Further to this the majority of this type of employee is housed.

Theoretically, the number of wharf gangs was doubled, as indeed it would have been had they all worked at one time with platform trucks or mobile cranes assisting. As and when vacancies occurred they were filled by filtering in the members of the more depleted gangs which, of course, then became non-existent.

This operation had to be carried out with due regard to race and religion as it is naturally politic to keep the Chinese and Indians apart and each in the same gang and also to keep Muslems from Hindus. It will be seen that by this method the full strength of each gang was maintained whilst the actual number of gangs was gradually reduced.

It was after this arrangement had been completed and in the light of experience gained that materials handling equipment was considered in a much broader sense. Many experiments were carried out with different types of petrol, diesel and subsequently, battery fork-lift trucks, and with different types of pallets.

During the early part of 1952 the Board sent a representative to the United States of America with the sole purpose of studying the methods, conditions and types of materials handling equipment employed on the main ports of the east coast of the Atlantic. This involved visits to New York, Baltimore, Philadelphia and Norfolk, Virginia. After considering the results of this study, the Board decided in favour of the 6,000 lb. capacity fork-lift truck as a standard unit. It was considered the most suitable truck for the type of work involved, being capable of tackling most unit loads with capacity to spare.

When all the preparations had been made, one berth was selected and declared to be a mechanical berth and was mechanised one hundred per cent. The two halves of each gang were again halved so that now it consisted of a quarter of an original gang or in other words approximately five men. This process was phased as far as was practicable to coincide with the labour drift or the number of gangs available, together with deliveries of fork-lift trucks by the manufacturers. Naturally, orders were placed as far as possible to coincide with this planning.

Great care was taken not to produce any marked affect on the labourer's pay packet or redundancy of labour. In due time each berth in turn was declared to be mechanised but prior to each declaration a rigid study was made of the numerical strength of the whole labour force, the number of fork-lift trucks and pallets available, together with the effect it would have on the daily roster drawn up by the labour office each week. In other words, it was brought into execution without any material effect on the labourers pay packet and without detriment to the Port's working.

Type of Pallet Adopted

It may be of interest to give a brief description of the type of pallets adopted by the Port and its use. The size is generally 48-in. x 54-in. with the straddle boards finished off flush with the two outside main members, the third main member, of course, being in the middle. Two holes of $1\frac{3}{8}$-in. diameter are bored through each outside member, four holes in all, and each strengthened by an iron shoe. A bridle is permanently kept on the ship's hook and is constructed of four wires with spreaders spliced to a ring bolt for engaging the ship's hook and the other ends, two each, shackled to two steel bars. Each bar has two studs corresponding to the holes in the pallet. The bridle therefore can easily be engaged and disengaged with a pallet by merely engaging or disengaging the studs with the holes in the side of the pallet. The pallet is used as the ship's sling and made up into unit loads, either in the ship's hold and retained as such until delivery to the consignee is effected, or, conversely from the lorry delivering goods for shipment until stowed in the ship's hold. Sometimes the system is extended, particularly with the discharge of homogeneous cargo such as cement in paper ply bags. Heavy hatches are expedited by simultaneously discharging onto the wharf and overside into a 300 ton capacity flat lighter with a fork-lift truck working on its deck, stacking each pallet load when received. Naturally an ample supply of tarpaulins is always at hand to counter inclement weather. During a meal time break the flat lighter is discharged back onto the wharf using portal cranes and fork-lift trucks, thus making it available for the next working period.

Transhipment Traffic

The Singapore Harbour Board has always handled a fairly high percentage of transhipment traffic and during post war years there has been a marked upward trend. It is customary for this traffic

Mechanical Handling at the Port of Singapore—continued

to be received, stored and then reshipped after the receipt from Agents of Delivery and Shipping orders. Special tariff consolidated rates apply to this traffic with concessional free store, rent periods. During the 1951-52 boom and the consequent congestion that occurred, serious delays were being experienced owing to shipments becoming blocked up in transit sheds and therefore not being available for reshipment when called for. This became serious enough to reflect adversely on this type of trade and owners considered sending cargo via other ports. The Board was quick to react to this trouble and constructed ten dolphin wharves with four storage sheds situated at the north wall of its Empire Dock, which is of stepped construction. Arrangements were made with some forty Agents and Owners to remove transhipment cargo immediately after its discharge at the Ocean berth by the first carrier and to transport it to the appropriate shed serving these dolphin wharves in readiness for reshipment by the second carrier, usually consisting mainly of small coastal ships. This scheme affords the distinct advantage of minimising congestion at the discharging berth and of avoiding the risk of shipments being blocked up and shut out. The scheme is operated almost entirely with unit palletised loads, which are transported, tallied and retallied as such. They are thus handled entirely by mechanical aids from the time they are made up in the hold of the first carrier to the time they are broken down for stowage in the hold of the second carrier. The distance of transport, particularly in some cases, is quite considerable and naturally, a cheaper type of porterage than that of a fork-lift truck was considered. The tractor-trailer method was adopted and found to be not only economical but efficient. Fork-lift trucks load up the trailers at the despatching end and others fork off and stack at the receiving end. If the loading ship is alongside and ready to take a particular shipment, the time of both labour and machinery is still further saved by running the trailers straight under the ship's hooks for shipment direct.

Documentation.

The Board's tariff was completely revised in February, 1954. Manifested tonnage was substituted for scale tonnage and classification of cargo for tariff rates dispensed with. This simplified the computation of tonnage and the compilation of bills. Rates were revised and some consolidated, and all were brought into line with costs. A penal store rent was introduced to discourage merchants from using the Board's transit sheds as warehouses but special warehouse rates and storage were made available. The system of delivery and shipment was reorganised. A ship's journal, copied from the ship's manifest with extensions for tonnages, rates and billing purposes, is made up before the arrival of the ship and sent to the berth concerned. Deliveries are then entered and tonnages checked. After the elapse of an appropriate period the journal is forwarded to the Accounts office for billing to consignees, with undelivered balances entered onto a supplementary journal. The benefit of such a system from a warehouseman's point of view is invaluable as short and overlanded cargo is easily checked, tonnages for billing and statistical purposes made available, and stock-taking always kept up to date. A similar system was introduced with the Board's duplicate shipping orders, covering all cargo shipped through and by the Board.

Regarding the materials handling equipment proper, advices are forwarded from the working area to the Accounts Offices who in turn compiled a monthly set of statistics to each tariff item. This information is invaluable when assessing the worth of each truck and the merits of the various types.

The opinion has been expressed that too much is heard of demurrage incurred by ships and not enough of demurrage of wharves. This, of course, is more applicable to transit ports than terminal ports, but nevertheless, serious demurrage to berthing is incurred which is just as serious to the Port Authority as the delay of ships is to the Shipowner.

It might be said that the yard stick by which to measure the work of a port is the tonnage of cargo worked per lineal foot. It is reasonable to assume that a transit port would show a higher figure than a terminal port but the Author believes that an approximate annual figure of 250 foot-tons is the capacity to which a port can be expected to work without incurring congestion and yet, with the method and system described, the figure was as high as 328 tons in 1952. During 1955 the figure was 306 and during 1956 it was 316 tons. These figures do not include the discharge of tankers or oil bunkers but they do include coal which, with modern requirements, is very small. It is believed that should the necessity arise, and all other things being equal, those figures could be comfortably increased. Experience showed that from the initial stages of mechanisation and general revision it became steadily easier to attain the standard of work that had been set, and the gradual easing of congestion throughout was most noticeable, largely due, no doubt, to the expeditious and more efficient throughput of cargo with a properly arranged tariff and system. The Singapore Harbour Board work an 84 hour week in two unequal shifts.

The capacity of a port is dictated to a great extent by its ability to deliver the goods and overcome the obstructions that are placed in the way by cumbersome processes and the extent of Customs activities and requirements when so doing. The requirements of the Customs in Singapore are such that a minimum of interference is experienced. Consequently, the flow of goods is practically unimpeded.

Preservation of Timber for Maritime Structures

By WM. E. BRUCE, M.A., F.I.W.Sc.
(Secretary, British Wood Preserving Association)

At the outset it is desirable to consider briefly those forces and destructive agencies against which defence work is necessary. These vary in different countries, even on different parts of the coast of a single sea board and in different rivers, but they fall into three particular categories:

(a) Mechanical wear from waves or flowing water charged with solid matter—rocks and stones, sand or grit and ice.

(b) Decay due to fungal infection, mainly *Chaetomium spp.* (*Ascomycete*) and other micro and bacterial organisms.

(c) Damage caused by marine borers, *Mollusca* and *Crustaceae*.

Mechanical Damage

Mechanical damage is worst on coasts during and immediately following storms and in estuaries at similar periods, especially when the winds are accompanied by heavy rains which lead to floods. The more important mechanical properties required in timber for the prevention of coast erosion are:

(a) Resistance to shock.

(b) Resistance to abrasion.

(c) Resistance to splitting.

In stormy weather, waves heavily charged with rock fragments, stones and shingle strike the defence works with forces not easily apprehended by the landsman, unless he has actually seen, as sometimes occurs, masses of concrete or rock tossed up on the beach or even strong sea walls destroyed. It is therefore essential that piling and to a less extent sheeting timbers should possess marked strength properties. Resistance to abrasion is necessary both in the case of untreated and treated timbers. It is important in the case of treated timbers as otherwise the outer layers of the timber in which the preservative may chiefly be concentrated would soon be worn away and untreated wood exposed. Even in river mouths and harbours, although the seas are generally less violent, there is always the risk of vessels, being driven by the wind or inexpertly handled, swinging with a strong tide against sea defences. Elasticity, or more correctly, the ability of the timbers to absorb shock is therefore desirable.

Pitch pine has generally been regarded as a most acceptable timber since it is resistant to abrasion and does not tend to split when driven as piles. Greenheart is considered good for resistance to abrasion but does tend to split if subjected to heavy

Preservation of Timber for Maritime Structures—continued

blows. Jarrah is another timber regarded as resistant to abrasion. In certain tests carried out at Shoreham Harbour against abrasion caused by tidal movements of shingle, brushbox appears to be showing the greatest resistance, followed by mora, greenheart, opepe and wallaba.*

The question of the preservative treatment of timbers for sea defence groynes is one which requires careful examination in relation to the actual coastal area in which they are to be used. Where there is regular, continuous and heavy abrasive action there may be little or no advantage in treating the timber, for although such treatment would give protection against marine borers, the normal life to be expected from the timber will be limited by mechanical damage. If, however, there is little abrasive action treatment would be well worthwhile. Even in areas where there is heavy abrasive action it is often of very real advantage to treat the timbers in the landward end or "pocket section" of the groyne and those in the "spur section" which is usually under water, although there may be little advantage in treating the main or centre section owing to the possibility of mechanical breakdown.

Fungal Attack

In a paper on "Marine fungi, the taxonomy and biology," published in 1944, Bardhoorn and Linder pointed out the role of *microfungi* in causing decay of timber submerged in the sea and proved that a number of different marine fungi, which they isolated, caused an attack of the "soft-rot" type.

When "soft-rot" occurs in water, the depth of penetration is limited, but if any form of abrasive action occurs the softened surface is more quickly removed and a new surface is exposed to attack. M. P. Deschamps in 1952 emphasised the role of fungi and bacteria in aiding attack on wood by marine borers.

Soft-rot has been observed in hardwoods and softwoods of all durability classes and it is by no means unusual to find superficial soft-rot on very durable hardwoods which have been chosen for a particular use. Soft-rot occurs most frequently between high and low water marks, where timber used in marine defence work is alternatively very wet through submersion and, though drier when the water recedes, yet remains damp. The timber is never dry or wet enough for a period of sufficient length to inhibit spore growth and so preclude the incidence of decay.

Marine Borers

The marine organisms causing damage to timber in British waters are generally molluscs such as the ship worm or *Teredo* and crustaceans such as gribble or *Limnoria*. The distribution of these marine organisms is not uniform and is affected by the degree of salinity and the mean temperature of the water.

Teredo usually enters the wood at right angles to the grain as larva 1/100th of an inch long and then proceeds to bore in a longitudinal direction following an irregular course. The mature worm may be over a foot in length. Wood becomes honeycombed and in time the structural strength of a pile may be so reduced that it will fail under the slightest stress. During the time of boring and development of the ship worm in the wood the entrance hole is only slightly enlarged, so that while the outer surface of the timber shows only slight perforations, the inside of the timber may be virtually riddled. *Teredo* occur round the coasts of Great Britain mainly south of the Clyde, but appears to cause the more serious damage around the southern half of England. The salt content of the water is of importance to the life of *Teredo*. It is reported that a salt content below 17.5 per cent. has an unfavourable effect on the activity of the animals, whereas a salt content lower than 4 per cent. is lethal. *Teredo* cannot, of course, live in fresh water. Two common species are *Teredo navalis* and *Teredo norvegica*, the former being the more common in British waters. Reports indicate that *Teredo navalis* become inactive in temperatures below 5°C. and that it is most active over the temperature range 15—25°C. and can tolerate even 30°C.

Crustaceans vary in their method of attacking and destroying timber. Unlike ship worm they do not become imprisoned in the wood, but are able to move about, especially in the adult stage. The young and old burrow into the timber, making narrow galleries which seldom extend far below the outer surface. Although these workings may be superficial, they often attack wood in such great numbers that the timber can become honeycombed around the many points of attack. The mechanical action of water, or the impact of floating objects breaks up the fine partitions separating the burrows and new surfaces are exposed for further attack, thus destruction continues, becoming progressively deeper, until ultimately the strength of the timber may be so reduced as to render it impossible properly to fulfil its purpose.

Limnoria will often attack the same timber as ship worm. It occurs round the whole of the coast of Great Britain, although it has been reported as being more destructive in certain areas than others. As in the case of *Teredo*, the salt content of the water affects the activity of *Limnoria*. Wood-attacking crustaceans normally need a salinity content of over 20 per cent. and it is reported that a salinity of less than 6.5 per cent. is fatal. Although *Limnoria* seem to be less sensitive to low temperatures than ship-worm, reports on tests indicate that boring activity increases fairly steadily from 5° to 27°C. In a paper presented at the B.W.P.A. Annual Convention, 1957, Professor J. E. G. Raymont of the Zoology Department, The University of Southampton gave an account of marine borers with special reference to breeding. It would appear that *Limnoria*, while withstanding low temperatures, is susceptible to lowered salinity, while *Teredo* can flourish in fairly low salinities, but is affected and limited by low temperature.

Natural Durability of Timber

No known woods are completely immune to attack by the various marine borers, although the heartwood of some species has been found to offer definite resistance to attack. It is believed that this resistance is possibly due to the presence of extraneous substances such as essential oils, resins, and other toxic substances or a high silica content. The presence of silica in untreated wood appears to be necessary to confer *Teredo* resistance and this was recently confirmed in the United States by tests on some forty species of South American woods. These showed that approximately 0.5% of $Si.O_2$ appeared to be minimum necessary for immunity from attack, but discussion at the Marine Borer Conference, Wrightsville, 1956, disclosed that no known specifications exist defining the minimum silica content of untreated wood for use in marine borer waters. The most resistant timbers are of foreign origin and include such woods as jarrah, totara, turpentine, azobe, manbarklak, angelique and greenheart, although the last named does not always have a particularly good record in tropical waters. The behaviour of wood does, however, appear to differ according to the geographical locality of the area of immersion, tropical waters generally being far more harmful than those in temperate regions. For the tropical waters it should, of course, be remembered that the destructive marine species are more extensive than in temperate zones. In an article which appeared in this journal in July, 1957 Mr. R. P. Woods dealt with the resistance of timbers to marine borers and also included a most useful historical survey. It is not, therefore, proposed to deal further with this matter.

Timbers for Marine Work

Timber used for coastal defence work should possess certain properties mentioned earlier, namely resistance to shock, abrasion and splitting, natural resistance to fungi and destructive animal agencies plus a high strength/weight ratio. Unfortunately, there are few timbers in which all or even most of these properties are to be found. In addition, certain of the timbers which have been found to be naturally durable and resistant are in limited or uncertain supply or, alternatively, their cost is high due in part to increases in extraction costs and freightage charges.

In a paper on "Timber for Marine Work" presented at the 1953 Convention of the British Wood Preserving Association, Mr. R. P. Woods stated that in Great Britain the favoured timbers for piling for sea defence groynes have been pitch pine,

*K. E. Cotton, B.W.P.A. Convention Record 1956, p.5.

Preservation of Timber for Maritime Structures—continued

greenheart, elm and Douglas fir. Other timbers which have been used are oak, jarrah, larch, beech, blue gum, pyinkado, turpentine and European white wood in approximately that order of popularity. For walings Douglas fir, pitch pine and elm were preferred with jarrah and oak following. Greenheart, European white wood, redwood, larch, beech, rock-elm, karri and brushbox had also been used. No particular preference had been shown for land ties apart from beech, pine, Douglas fir and oak. Mr. Woods also dealt with the use of timber in docks and harbours. He recorded that among the timbers used for piling were Memel redwood, greenheart, pitch pine and Douglas fir. For other uses in dock and wharf construction elm, oak, jarrah, pyinkado, karri, brushbox, larch, beech and blue gum were noted as having been used.

Preservation of Timber

It is possible by proper preservative treatment to give to many timbers protection against decay and attack by marine organisms. Thus softwood timber which possesses the other desirable properties, is available in suitable sizes and is relatively cheap, can satisfactorily be used for marine work. Softwoods also have the advantage of being easier to work and to handle than some of the hardwoods and some of them, such as British Columbian pine (Douglas fir) are available in large sizes. They are also easier to build on and around than certain other alternative materials and are resilient to impact from craft in difficulties in rough seas. In America southern pine is also widely used for marine work. For sheeting, European redwood may be employed in harbours and fresh waters but it is not available in large sizes and its strength properties are generally inferior to those of Douglas fir. Treated elm is another suitable timber for sheeting.

In waters where marine borers are active cases have occurred of untreated piling being destroyed in a year or less. In the same waters the life of properly treated timber is estimated at 15—20 years and in many cases treated timber has been found to be sound after 50 years or longer. Unless, therefore, a timber of proven durability is used and can be used economically, it is advisable for timber used for sea defence groynes, decking, piling, piers, jetties, wharves, lock gates and fendering to be treated. The essential features for preservatives used for the treatment of marine timbers are resistant to leaching, high toxicity against marine borers and good penetration. In the case of the less permeable timbers, such as Douglas fir, incising before treatment is to be recommended.

The American Wood Preservers' Association include in the Manual of Recommended Practice a Standard C.18.54 for pressure treated piles and timbers in marine construction. Timbers included in the table for round timber piles are Southern yellow pine, Norway pine, Douglas fir and red oak. In the list for substructures exposed to tides and running waters, bench caps, plumbposts, bracing, cribbing, sheet piles, fenders, chocks, etc. Norway pine is omitted but gum is included. Different preservative retentions are given for timber in coastal waters and that in fresh water or ground contact. A higher retention is normally recommended for timber in coastal waters. For substructure normally out of the water such as timber caps, stringers, subfloor decking, chocks, etc. only Southern yellow pine, Douglas fir and gum are mentioned. For timber superstructures, posts, trusses, rafters, purlins, sheathing, walkways, backing, and composite deck laminations Southern yellow pine, Douglas fir, gum and red oak are included.

In the United Kingdom timbers which have been included in schedules for marine piling are beech, elm, larch, Douglas fir, pitch pine, European redwood and Scots pine. Before treating any of these timbers incising is regarded as essential. It has been generally agreed that where a non-durable timber is used for marine work it should be treated by impregnation under pressure with a suitable preservative. With creosote net retentions are of the order of 5—16 lbs. per cu. ft. depending on the species and size of timber treated and the purpose for which it is to be used. With water-borne preservatives net retentions range from 0.25 to 1.25 lb. of dry salt per cu. ft. of timber varying with the preservative and the end use of the timber.

In the past creosote has been the most widely used preservative for treating timbers for marine work, particularly for piling, fendering, groynes and river defence works, but in recent years certain authorities have also used water-borne preservatives of the copper-chrome and copper-chrome arsenate type. Pentachlorophenol has also been recommended for bridge construction, pier and jetty decking, as well as the preservatives mentioned in the previous sentence. Tar has also been used as a preservative medium. Its value probably lies in providing a protective coating even though it is not used as a true preservative, although parts of the oils, etc. in the tar may be absorbed by the wood. An important point is that the coating should not be broken. In leaflet No. 46 issued by the Forest Products Research Laboratory reference is also made to the use of copper naphthenate.

At the 1956 Marine Borer Conference held at Wrightsville, the Chairman of the American Wood Preservers' Association Committee on Wood Preservatives reported that evidence had accumulated that a solution of creosote in coal tar had advantages for marine preservation. Mr. Trussell of Canada reported on the use of sodium arsenate to protect logs against *Teredo* and *Limnoria* when held in storage for pulp and paper mills in North-West Canada and the United States. Mr. Miller of the University of Miami described work on the use of copper formate impregnation followed by autoclaving. He also mentioned test samples treated with Tetramine cupric sulphate and tannic acid followed by cupric acetate, though the size of the test samples was criticised by certain delegates. Dr. Smith from the University of Miami reported work in progress on the toxicity of derivatives of Azobenzine to *Teredo* and *Limnoria*. At the present time the B.W.P.A. in collaboration with the T.D.A. is carrying out a series of fendering tests in Poole Harbour utilising a wide range of preservatives at different concentrations and applied by different methods and a further set of screening tests are in progress at Shoreham Harbour. It is, however, too early as yet to comment on these particular tests.

Improvements at Devonport, Tasmania

The Devonport Marine Board recently announced that preliminary work has commenced on the new Bass Strait ferry terminal at Devonport, on the River Mersey, Tasmania.

Most of the work planned for the port in the next two years will be concentrated on the ferry terminal, the main section of which will consist of mooring facilities, a stern loading ramp, marshalling area and reception building. Other constructional works scheduled during the period are a new amenities building for waterside workers, and an extension of the present wharves to provide a berth for grain ships.

Working plans and specifications for the new amenities building have been almost completed. The work will be carried out by contract, and is expected to begin before the end of this year and will be finished shortly. The building, which will be erected at the northern end of the new shed on the caisson wharf, will be in red brick and reinforced concrete. It will be two storeys high and about 70-ft. long by 30-ft. wide.

A canteen and pick-up centre will be housed on the first floor, while the Waterside Workers' Federation and Australian Stevedoring Industry Authority offices, first aid centre and toilet facilities will be on the ground floor.

Work on the £50,000 steel and precast concrete shed on the caisson wharf is nearing completion. Tenders were let recently for the installation of wiring for the fluorescent lighting. This shed has a clear span of 360-ft. by 80-ft., and a clear height of 20-ft. These dimensions will facilitate the use of mobile plant and will allow maximum storage space. It is being equipped with 20-ft. square sliding doors.

Considerable dredging work has been carried out alongside the caisson wharf and in the new wharf swinging basin. Spoil has been pumped to East Devonport where eight acres is being reclaimed. This will bring the total area of land reclaimed by the board to 31 acres. Reclamation of 23 acres on the western shore of the river was completed some time ago, and much of it is now in use.

Modern Dry Docks: Design, Construction and Equipment

III. Siting, Design and Construction

By P. F. STOTT, M.A., A.M.I.C.E.

(Continued from page 260)

Design

The most characteristic and critical design factor associated with a dock is the water conditions in the ground surrounding the structure, and the extent of the problem posed and the attitude of the engineer towards it determines to a large extent the final design. Except in the most favourable circumstances the designs adopted for walls and floor must be considerably modified on this account from those forms which would resist most economically earth pressures and transit most economically ship loads to underlying strata. It is the effect of water loads above all else which requires that a dock section be designed as a whole The walls and floor are not, in general, independent units and in every case their interaction must be considered.

The analysis of dock sections can never be a satisfactory exact theoretical exercise. Even if the intended structure is itself simple the surrounding earth masses are unlikely to be homogeneous and their elastic properties, upon which depends the exact interaction of forces, can seldom be established with precision. It is usually appropriate therefore to make broad simplifying assumptions which render the problem amenable to calculations. The consideration of limiting cases will demonstrate the suitability of a particular trial section and provide that the actual conditions will be comprehended.

Usually the methods of analysis employed are those in general use and are not special to dock problems. For this reason no detailed description will be given here, and the reader is referred to published works[11, 12] for particular examples. It is of interest to note that such developments in structural analysis as model techniques have been employed, the stresses in one modern design of monolithic dock section being determined by photo-elastic methods[13].

The calculation of earth pressures is an important aspect of dock design and it is part of the general advance of engineering techniques that although these matters cannot be treated exactly, methods of great power employing a judicious application of rational and empirical knowledge are now available. A recent code of practice[14] gives a clear account of the subject as a whole whilst special problems of flexible walls may well be amenable to recent methods developed by Brinch Hansen[15] and Rowe[16].

Before proceeding to consider the variety of designs which have been employed to meet specific site conditions there is one aspect of the problem of dock design which must be stressed. That is the absolute necessity for comprehending the appropriate construction methods in the original conception. Design cannot be separated from problems of construction and what is finally built must often be a compromise between the most efficient structural form and the demands of constructional convenience.

The simplest dock designs are those where upward hydrostatic pressure beneath the floor is non-existent or where the conditions of permeability of the strata are such that relief of pressure by drainage is feasible. Where the foundation is rock there is no problem of bearing for ship loads and a thin skin of floor concrete is generally all that is needed, more to provide a good working surface than for structural reasons. Underfloor drains leading to non-return valves are provided in cases where the strata are not impermeable. Two examples of old docks on such sites may be seen (Figs. 7 and 8) and for comparison a recent dock of the same type (Fig. 6)[10]. It is of interest to note that the basic treatment is the same, but the modern dock has a vertical wall with cantilever altars, a profile which in this instance has the advantage that the cope is brought forward, reducing the working radius of the main cranes and improving the access of smaller cranes to the side of the ship. The walls shown in all three examples are of mass concrete construction, weepholes being provided above rock level to drain the filling material.

Somewhat similar basic conditions to those in which these docks were built, but with the hard material being boulder clay, have recently produced two docks of novel design on Tyneside[5, 7]. The conditions were not identical and differing assumptions underlie the designs. In the dock built for Smith's Dock Co. Ltd. (Fig. 9) the clay is revetted by steel sheet-pile walls and the floor is designed on the premise that hydrostatic pressure up to mean tide level might develop beneath it. The method of construction envisaged the installation of sheet-piles as the first operation followed by bulk excavation and concreting of the floor.

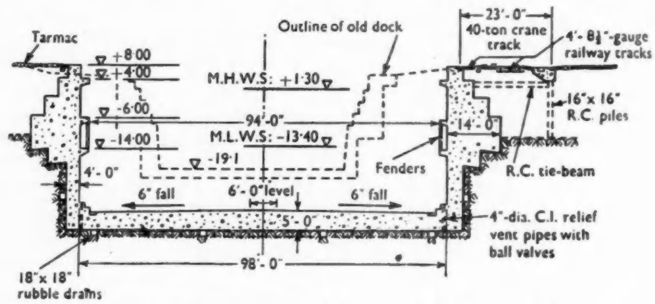


Fig. 6. Cross section of Greenwell's No. 1 Dock.

The dock built for Brigham and Cowan Ltd. on the other hand, was designed on the assumption that bulk excavation could be carried out first, the clay being strong enough to stand unsupported. The method of revetting the clay face of the wall (Fig. 10) involved the use of precast concrete buttresses* connected by panels of concrete placed insitu. Where the dock floor was founded upon the boulder clay it was assumed that significant hydrostatic pressures would not develop and a thin unreinforced concrete floor sufficient to transmit ship loads was adopted.

Another recent example of a dock constructed in clay with relief of water pressure is that at Nakskov in Denmark[18]. Here the sections employed are of a remarkable lightness.

Conditions on reclaimed sites are never easy to compare with other situations but in the two large wartime docks previously mentioned the foundations were in each case on relatively impermeable rock and the sections (Figs. 11 and 12) afford an interesting comparison between the massive wall constructions required by the great depths and the comparatively thin vented floors.

By reason of the situation in which dry docks are built close to waterways, cases predominate in which the structure is subject to full hydrostatic uplift, incapable of economic reduction by drainage. The uplift can be resisted structurally in two ways: by weight or by anchorage.

The method originally easily available is exemplified by the tradtional form of dock construction in concrete masswork which

* This technique was derived from the earlier successful employment of precasting methods in the reconstruction of Barry Commercial Dock[17] (Fig. 8).

Modern Dry Docks—continued

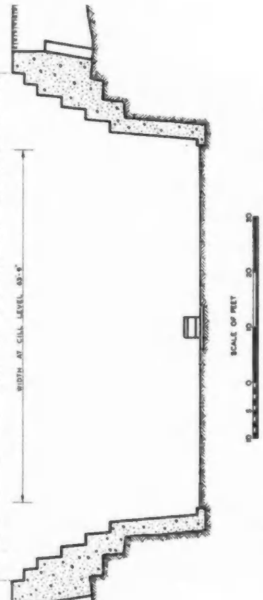


Fig. 7. Cross section of Dry Dock at Milford.

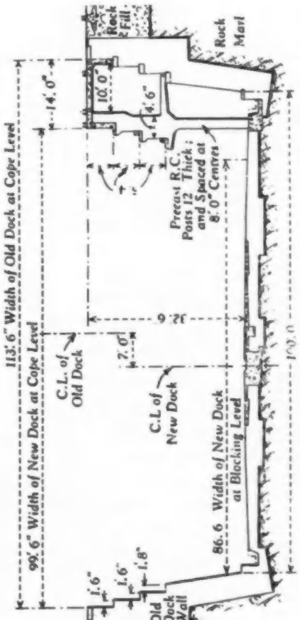


Fig. 8. Cross section of Barry Dock showing old walls and new false altar structure.

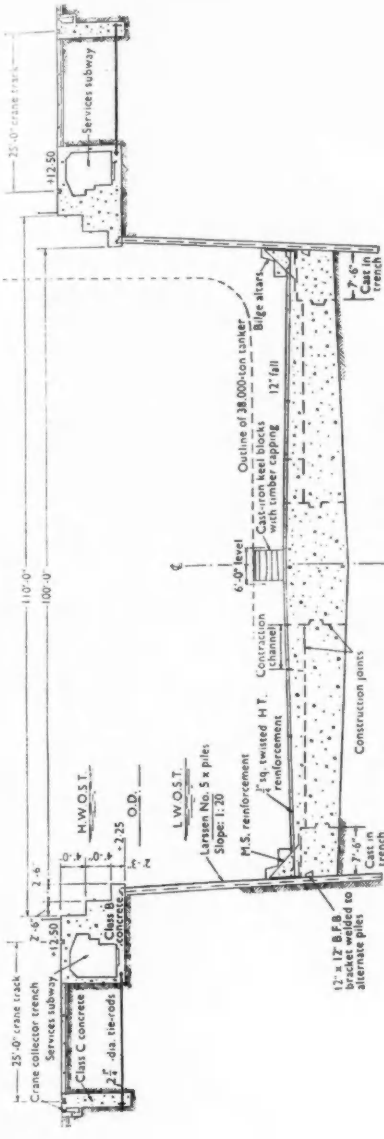


Fig. 9. Cross section of Smith's No. 8 Dock.

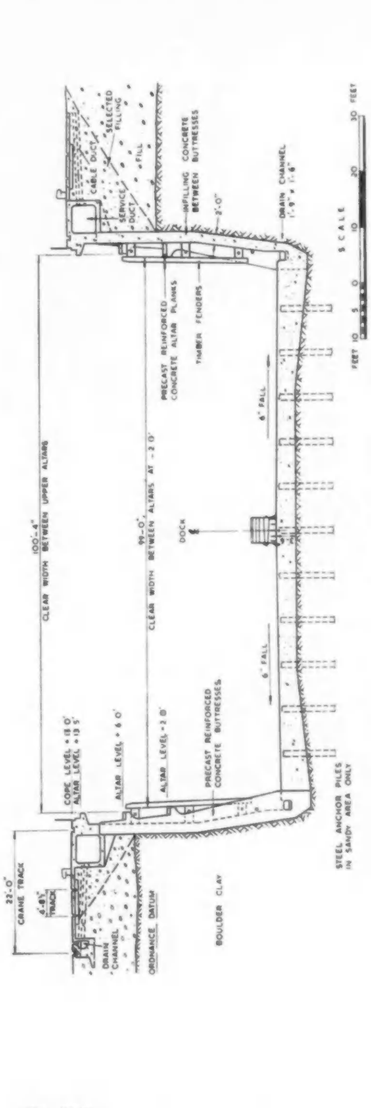


Fig. 10. Cross section of Brigham & Cowan's dock.

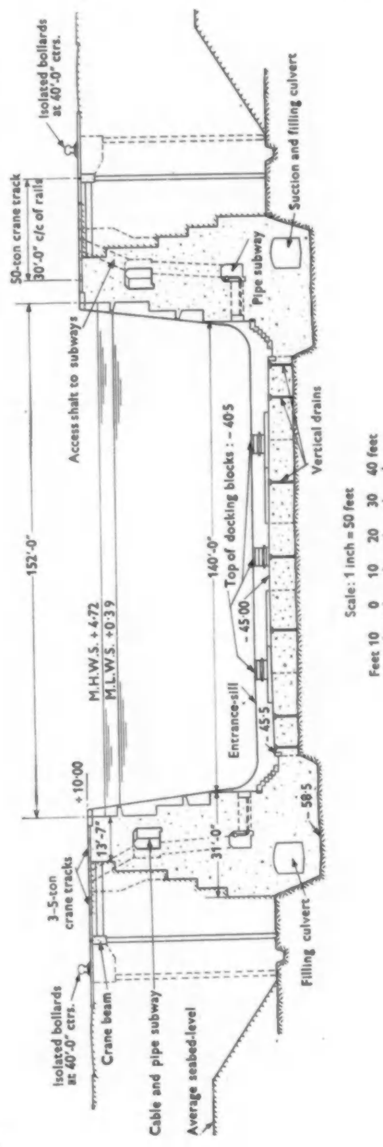


Fig. 11. Cross section of Captain Cook dock.

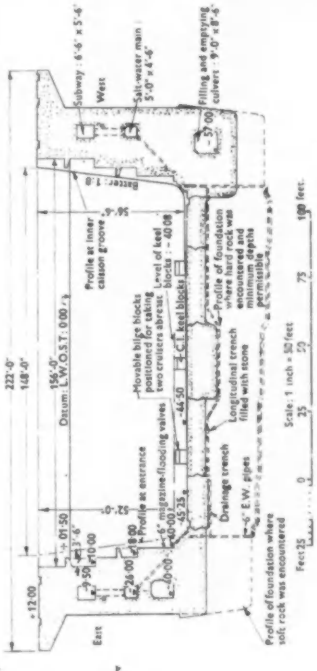


Fig. 12. Cross section of Sturrock dock.

Modern Dry Docks—continued

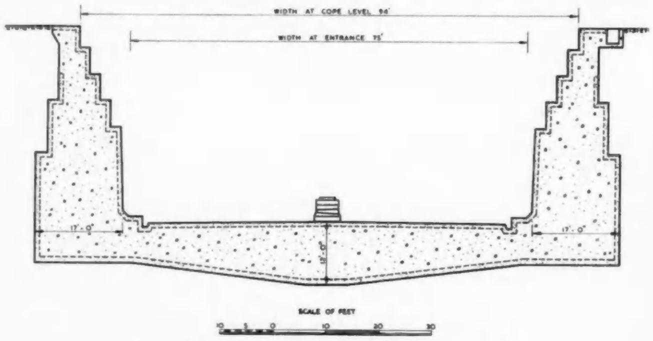


Fig. 13. Cross section of Swansea dock.

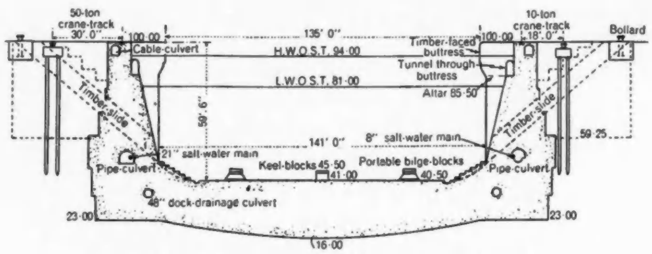


Fig. 14. Cross section of King George V dock.

in its finest application is both simple and elegant and by the standards of earlier years was impossible to match for economy and practicability in execution. Essentially this masswork dock is a structure which resists the uplift by weight, and in particular by weight of concrete. The floor of this type of dock is designed as an inverted arch transmitting to the abutting mass concrete sidewalls the reaction resulting from the net upthrust due to the hydrostatic pressure. The Palmer's Dock of the Prince of Wales Dry Dock Co. at Swansea is a good example (Fig. 13) while the King George V Dock at Southampton is a more modern example on a larger scale (Fig. 14). The method of construction which commonly accompanied this design was the building of the walls in trench usually from an intermediate excavation level, followed by excavation of the dumpling left between completed walls and the concreting of the floor. This last operation was usually undertaken in similar fashion to an arch bridge construction, a number of separate voussoir blocks being concreted between skewbacks on the finished walls.

While the arch action has long been held to be the most characteristic feature of the old designs, in modern practice this purely structural action is secondary to the principle by which the concrete mass resists the upthrust. The tendency is now for the floor to be regarded as a beam spanning between the side walls and in effect one might say that this is a repetition of the corresponding trend in bridge structures where the beam conception is now generally in the ascendant over the arch. Further than this, it is now widely held that in many situations the resistance to uplift is provided more economically if some of the weight is derived from natural filling materials brought into play by the form of the construction.

However, there have been docks built in recent years in special circumstances where the weight is provided by the concrete structure alone and the floor is designed as a beam. Two of the most interesting examples are provided by docks at Copenhagen and Trieste where either the whole or part of the dock has been built by a prefabrication technique in the sea. At Copenhagen[18] the side walls were formed by reinforced concrete caisson units built on a slipway, launched, transported to site and placed on a bed prepared by dredging. Once in position the caisson units were filled with concrete and the floor cast between them by underwater concreting through a tremie pipe. Fig. 3 shows a section of this dock. At Trieste[19] two prefabricated cellular pontoon elements (Fig. 15) were used to carry the dock construction forward on the seaward side of an existing sea wall. This

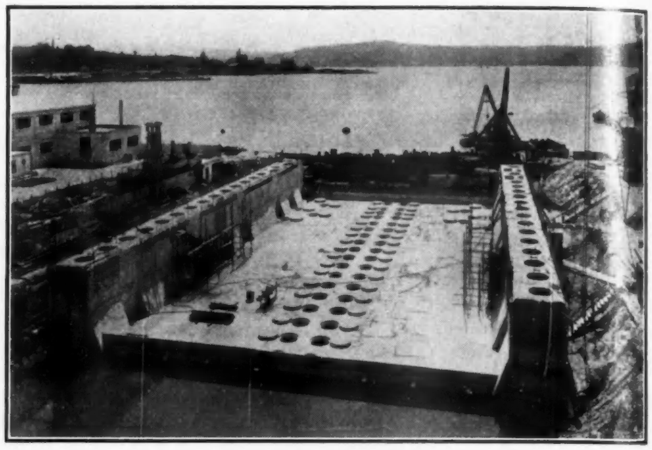


Fig. 15. Trieste dock: Pontoon unit.

work is of special interest in so far as that a good foundation was not available for the floating units and they were founded on four rows of large cylindrical bored piles driven through holes preformed in the pontoons. After this operation the pontoon cells were filled with concrete.

As has been mentioned above, many docks are now built in which a substantial part of the weight resisting uplift is supplied by fill. In these instances the construction is generally of reinforced concrete (albeit of a massive nature) the filling material being usually carried upon a projecting heel of the dock wall. Although retaining walls of this type have been employed for many years, the extension of the principle in modern form to dock construction in this country has lagged and there are few records of it except for its employment in the dock recently completed on the Tyne for Swan Hunter[6] and in a dock now under construction at Swansea.

The method has, however, been widely used on the Continent and in Scandinavia. Perhaps the best examples are the three docks recently built in Holland[8]. Fig. 16 shows a cross section of the twin docks at Schiedam. The chief contribution of the filling material is as ballast for the central division between the docks. Some rests upon the sloping backs to the side walls much as weight is carried upon the stepped backs of the older masswork constructions. Fig. 17 shows a construction more typical of the best use of filling. Generous toes are provided and the walls are little more than an economic structural thickness bearing in mind that the normal economic proportions are altered by the useful weight of such concrete as is provided.

The second main category of resistance to uplift is that obtained by anchorage, a method which on a suitable site can effect considerable economies in construction. Examples are as yet few but progress is likely to be in the direction of further applications of the method.

The recent Brigham dock on the Tyne, the basic design of one section of which has been described above, offers an example of a successful application in British pactice. As has been said the site is overlain by stiff boulder clay but with the variability characteristic of this material there lies beneath one large section of the floor a deep bed of waterbearing sand and silt. To resist the upthrust from this, the dock floor has been anchored by driving steel piles deep into the substrata and connecting the heads of these piles into the lightly reinforced floor slab (Fig. 10). In this way the normal profile and construction of the walls are maintained independently of the differing conditions beneath the floor.

Another example of an anchored floor is provided by a dock completed at Emden in 1954[20] (Fig. 18). Here the floor has been prestressed to the subsoil by means of steel cables anchored to reinforced concrete blocks of cruiciform section jetted into the sandy ground to depths of from 11 to 14 metres. This novel application of prestressing well suited the particular site condi-

Modern Dry Docks—continued

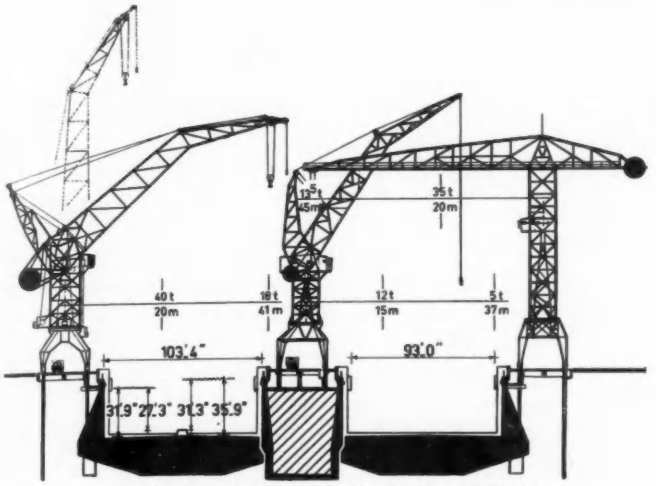


Fig. 16. Cross section of twin docks at Schiedam.

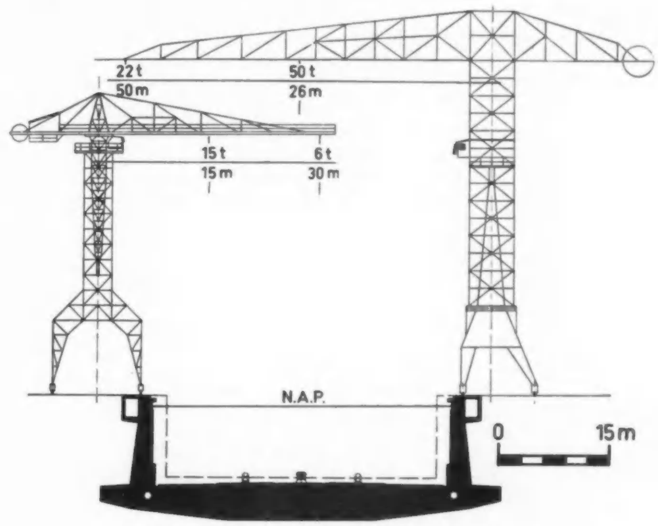


Fig. 17. Cross section of dock at Amsterdam.

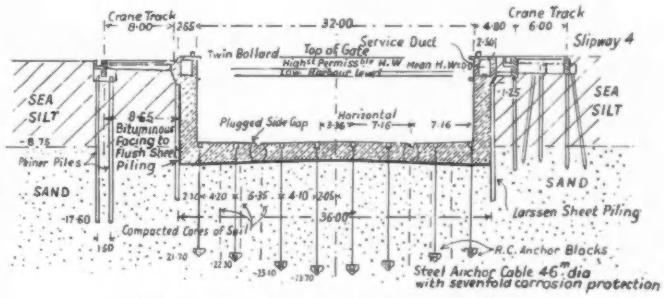


Fig. 18. Cross section of dry dock at Emden.

tions especially as the general methods of construction obviated the principal dangers of instability in the subsoil created by the jetting process.

Dock Planning and Equipment

In the introduction it was made clear that the interest and responsibility of the civil engineer in dry dock work extend beyond the major design problem of the dock structure to a concern with the planning and equipment of the dock for its use by the owner, considerations which must indeed always affect the details of the structure itself.

Quite apart therefore from the expert and specialist province of the suppliers of particular items of equipment there is an opportunity for the engineer to develop a quite distinct attitude to problems of equipment based on a broad view of the characteristics of the plant itself and its contingent requirements in the dock structure. In the following, various aspects of dry dock work are discussed from this viewpoint.

Main Pumping Plant

Apart from capacity concerned with supplies to dockside services and with drainage of seepage water, the main pumping requirements are for the dewatering of the dock from the flooded condition. The owner will specify the time required to pump out, a common figure for modern docks being 4 hours without a ship in dock. It is with these big pumps, whose capacity is thus specified, that we are here chiefly concerned, the provision of a suitable pumphouse and discharge pipes being a major expense of dock construction.

Site conditions generally require that the pumphouse be situated near the dock entrance (giving a short discharge) and immediately at the dock side (giving easy ingress of water to the suction sump). In such a position the whole structure must nearly always be built entirely below cope level giving an unobstructed working area alongside the dock, although in some favourable instances the pumphouse has been carried above cope level in a substantial building set back from the dock edge. Construction of this type below cope is generally expensive and it is apparent that as far as structure alone is concerned the most compact arrangement will be the most economical.

In view of this it is not at all surprising that the modern trend, aided by developments in pumping machinery and valve arrangements, has been towards such compactness and economy of layout. From the standpoint of purely structural economy the features of modern practice which especially commend themselves are:—

(1) The use of electrically-driven pumps. This is important by reason of the flexibility of arrangement which is permitted thereby.

(2) Vertical spindle units, where the motor is mounted directly above the pump, enable a substantial reduction in pump floor area to be made.

(3) Mixed-flow or axial-flow pumps offer some slight advantage in compactness over centrifugal pumps.

(4) The use of syphon discharges with consequent elimination of valves in the pumping line lessens demands on pumphouse space but makes its own special demands on the structure.

When it is appreciated that even in the simplest installations the cost of the pumphouse may at least equal the cost of the equipment installed therein, the above point of view must be given some relevance in the overall consideration of a pumping plant. Mechanical considerations also support these preferences in some cases and recent examples reflect the present consensus of opinion on the matter. Vertical spindle mixed flow or axial flow pumps have been specified for docks at Copenhagen[18], Emden[20], Swansea, Amsterdam[8], Nakskov[18] and Trieste[19], while vertical spindle centrifugal pumps were installed at South Shields[7] and Den Helder[8] and horizontal spindle centrifugal pumps at North Shields[6], Schiedam[8] and Wallsend[6], all these installations having syphon discharges.

Dock Gates

The following types of dock gate are now in use in dock installations:—

Sliding caissons
Floating caissons, free or hinged
Mitre gates
Box gates

The choice of dock gate to be employed in a particular installation is governed by the following main considerations:—

First, efficiency and economy of operation. The owner will be concerned with the number of men required and the time

Modern Dry Docks—*continued*

taken to open and close the gate and with its general reliability and that of its associated machinery. One factor determining reliability is the general robustness of the structure.

Secondly, suitability for the local site layout. For a particular gate this implies that the gate recess and any associated structures and machinery can be incorporated without substantial interference with other functions of the dock.

Thirdly, cost. The comparative cost of gates must include not only the cost of the gate itself and any machinery but also what must be our special concern here, the cost of the necessary provisions in the dock structure.

With this background we can now proceed to consider the main features of the various types of gate as they appear when a choice has to be made.

1. **Box Gates.** Box gates (sometimes called flap or falling leaf gates) are now most popular for general use both in Britain and on the Continent. They are quickly operated by one man, simple in construction, easily stepped or unstepped and can be adequately maintained without great loss of working time. The cost of the gate and machinery is comparable with that of other competing types with the exception of certain types of floating caisson to which reference will be made later. The greatest advantage of the Box gate is the economy of the provisions which are required in the dock structure. The mounting is simple and inexpensive and the gate recess can be reduced in width compared with nearly all other gates which results in a saving in overall length of dock construction, the only substantial requirement being an underground pit for the operating winch.

2. **Mitre Gates.** These gates, once widely used in dry dock work, have now been virtually supplanted by the Box gate. They are less robust than the latter, the fixed mountings are more susceptible to serious damage and they offer no advantage in ease of operation or in overall economy, being usually more costly.

3. **Sliding Caissons.** These have generally been employed on large docks. They offer a robust structure of high strength suitable for large openings which is nevertheless easily and quickly operated by machinery. Their disadvantage is high cost, which must make the likelihood of their use in present day commercial practice very questionable, especially as recent experience seems to indicate that in some instances a Box gate could perform the same functions. The dock structure must provide a camber into which the caisson is retracted and this itself may be likened to a dry dock in miniature, which in fact it often is, being so adapted for the maintenance of the caisson.

4. **Floating Caissons.** In present practice floating caissons are employed in their traditional form in the largest docks, where they possess the great strength required and where their very nature makes them suitable for use as intermediate closures in the dock length. Even so, it is doubtful whether on grounds of economy their use in new construction will not be limited by the challenge of the Box gate except where special circumstances occur.

Where floating caissons have been employed recently on docks having an entrance width up to 100-ft. the tendency has been to employ new techniques to render their use economical. The new twin docks at Schiedam[8] are fitted with buoyant gates not free but hinged on one vertical side. This device has in the particular circumstances allowed easy mechanical operation while the width of the gate structure is much smaller than is normal with a floating caisson, the normal stability requirements being inoperative.

The floating gate has traditionally been a steel structure of shipyard origin but in recent years instances have occurred where considerable economy has been effected by the use of civil engineering methods and materials in the design and construction of caissons. As this is perhaps outside the scope of the specialist articles which will follow, it may be of interest to refer to the technique employed in the construction of the new gates at Barry[17]. Here (Fig. 19) the skin is formed of structural steelwork channel sections while the lower decks are of reinforced concrete. In this case, and in others, the capital saving

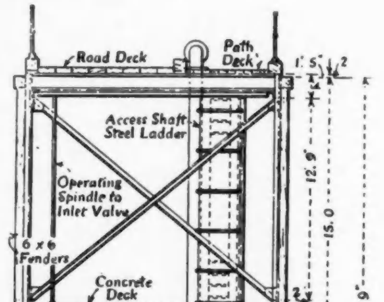


Fig. 12. Cross section of floating caisson at Barry Dock.

over gates of the Box type, which are admittedly more efficient in operation, has been sufficient to justify the adoption of floating caissons by the owner.

The problems of meeting - face construction are part of the general question of dock gates. Meeting faces were traditionally formed by timbers on the gate and granite blocks in the dock structure. Timber is still generally employed on the gate but its sealing action is now frequently supplemented by the use of a continuous rubber strip fastened on the water side of the timber or forced into a recess therein. The sharply rising cost of granite and the scarcity of skilled masons has led to a great diminution of its use, the modern substitute being often precast granolithic concrete blocks carefully set and ground to the required standard of accuracy. The free use of concrete has been encouraged by the adoption of Box gates as sliding on the butting faces does not occur and wear on the concrete is thereby avoided.

Steel-to-steel bearing with rubber sealing has been employed but this type of meeting face has not been generally adopted[10].

Services

The conception of a dock as an open air workshop means that the provision of services should be on a scale commensurate with modern methods and tools and capable of easy maintenance in what can be onerous conditions. The range of services required depends on the decision of the owner but some at least of the following provisions will generally be made:—

At cope level: Electric supply either D.C. or A.C. (or both) for ships, portable tools, lighting and welding; compressed air; oxygen and acetylene; fresh water; sea water for ballast; fire hydrants; steam; fuel oil; oily water.

At dock floor level: Electric supply for lighting and portable tools; compressed air; oxygen and acetylene; fire hydrants; sewage.

To accommodate these services it is usual to provide a subway along each side and around the head of the dock. This subway is normally formed in the body of the wall and (in commercial practice) at as a high a level as practicable. The subway should be of sufficient size to allow easy man access and adequate working space for repairs and whatever the initial specification of services at the time of construction a margin should be provided for the installation of further services at a later date. Suitable arrangements are necessary to allow branches to be taken to recesses in the coping or to the floor of the dock. The most flexible arrangement, which well suits the general working of a dry dock, is found when the cope is far enough above maximum dock water level to allow branches to be brought out through open ports to connection points. This is not often possible however, and recourse must be made to covered recesses and pits or, in some cases, to pipes upstanding above cope.

Typical subway provisions in modern practice are shown in the cross sections of docks included herein.

Provision for ventilation, drainage and lighting of such subways is necessary. Where possible care must be taken to ensure

Modern Dry Docks—continued

that in the event of serious damage to the dock wall the flooding of the subway cannot lead to flooding of the pumphouse; this implies that provision must be made at least for the isolation of the pumphouse from the subway by watertight doors.

Miscellaneous Equipment

Keel Blocks

Keelblocks were traditionally of hardwood such as oak surmounted by softwood cappings. In modern ship repair practice such blocks still survive[18] but the general opinion now favours cast iron or cast steel blocks made up of three wedge shaped elements, the capping being again of softwood. Variations have been tried but these have generally been found unsuitable in practice. Concrete plinths fixed to the dock floor obstruct repairs while removable concrete lower blocks are often not durable. Mild steel fabricated blocks have been used but, in some cases, have proved to be insufficiently robust to withstand the ramming technique employed to free blocks prior to their removal for access to the keel.

Timber blocks, being buoyant require to be secured to the dock floor to prevent flotation. Iron or steel blocks usually require to be anchored where they are sited in way of flooding culverts and pump suctions, to prevent movement by the wash of water, and also where the first contact of the keel occurs during suing, to prevent tripping.

Bilge Blocks

The modern tendency to dispense with side shoring remarked upon in a previous article has been hastened by a considerable

Fig. 20. General view of dock at Emden showing mechanical bilge blocks.

development in the use of mechanically operated bilge blocks. Early examples of this type of block are to be found in the largest dry dock at Tilbury[21] and at the Gladstone Graving Dock, Liverpool. Later developments have led to simple and robust arrangements probably less expensive than either of these.

Two main types can be distinguished. The first are those in which little attempt is made to regulate the exact point of contact of the blocks with the ship. At Emden (Fig. 20) the bilge supports consist of steel girders placed transversely to the centre line of the dock. The bearing nearest the centre line is hinged whilst the outer bearing can be raised by means of chain operated elevating screws so that the timber capped girder is pressed against the ship's bottom. At Schiedam, wedge-shaped fabricated steel bases anchored to the dock floor form a ramp up which buoyant upper blocks can be pulled by chains to make contact with the ship. Yet another variant of this type of bilge block is shown by the installation at the Mercantile Dry Dock at Antwerp where the installation consists in effect of a number of air operated screw jacks in fixed positions on the dock floor.

The second type of mechanical block is one in which the exact position of contact transversely can be arranged without difficulty. Blocks of this kind installed at Copenhagen[18] are generally similar to those at Schiedam except that not only the upper block but also the lower wedge block is movable. Here again the operation is by means of chains.

It must be emphasised that these mechanical bilge blocks, although able to withstand considerable loads, are not intended to achieve more than a steadying of the ship and the small numbers in which they are usually employed reflect this. Local bottom shoring to take specific loads such as those due to tank testing is always required.

Provisions for Main Cranes

The specification of a dock crane is principally a matter for the owner and the crane designer but, as in other instances where dock equipment is concerned, the dock structure may have some bearing on the matter. The first point is that the centres of rails should if possible be settled at a figure which will allow the best use of the dock structure itself to be made in providing the necessary support. Secondly the comparative costs of providing trailing cable or plough collector current pick-up to the crane are affected by the structural costs involved. Purely on a basis of first cost trailing cable supply can usually be shown to be more economical when the overall figures are to hand.

Control of Ships when Afloat

In his general survey, Champness has referred in some detail to the necessity for adequate control of ships entering or leaving the dock. The measures which he suggests have to some extent been adopted in the more advanced of recent docks where the owner's view has been similar to that which he expresses.

The most outstanding feature which has been adopted in docks both at Copenhagen[18] and Antwerp is the same in principle as illustrated by Champness (Fig. 5)*. In each installation hauling winches at the dock head pull travelling towing carriages along special rail tracks running the length of each side of the dock. The restraining effect of stern tugs enables the head ropes to be kept taut so that they exercise effective control of the ship's head.

Even such innovations do not remove the need for capstans at the entrance and a considerable number of bollards and fairleads around the dock. Bollards will generally require to be not more than 100-ft. apart. Their actual position relative to the cope edge is always subject to the particular circumstances of the dock. In view of the great height above water line of large ships in light condition, the further bollards are from the dock the better in order to reduce rope angles, but in practice this ideal cannot always be met.

General

The variations in dock work are such that it is not possible to establish a code of practice and in the foregoing attention has been drawn to recent practice and the general background of thought which underlies the design and planning of such installations has been indicated. A more detailed and comprehensive statement of principles is contained in the Memorandum on Construction and Equipment[22] and although considerable assistance may be afforded in the study of a new project by this publication it will be recognised that every dry-dock problem must be considered strictly on its own merits.

* See page 171. "Dock and Harbour Authority," September, 1957.

(For References see foot of following page)

Food Infestation at Ports

Need for Improved Standards of Hygiene in International Trade

By W. McAULEY GRACIE, M.B.E., F.R.S.H., M.Inst.T.

The world problem of infestation has many facets. International trade has in many ways added to the complexities of this problem while the physical and social conditions in individual countries have placed local emphasis on certain particular aspects of infestation.

The economic conditions of producing and consuming territories have a great bearing on the general level and on the ebb and flow of infestation, while the internal economic policies have a contributory effect.

Natural conditions have been much disturbed over many years by international commerce and there is to-day no clear pattern of infestation based on the original homes of the many species of pests.

In the course of international trade many creatures have been involuntarily transferred to new environments. If the climatic conditions and other factors in the new surroundings have been harsh the imported creatures have not been able to establish themselves either at all or as a virile race and consequently do not appear as material factors in the infestation record of those particular territories. On the other hand, the involuntary transferees might and often do find in the new territory living conditions approximating to those under which they had developed in the countries of origin or, alternatively, might adapt themselves to new living conditions involving change of habit such as becoming "structure" as well as "field pests."

As international traffic is necessarily at least a two-way affair it follows that infestation originally introduced into a particular country may so tighten its grip and develop that it becomes an export of that country to other parts of the world. From this it will be observed that there is an extensive infestation exchange working side by side and closely linked with international commerce.

Under the influence of climatic conditions the intensity of infestation shades off from the tropics to the poles and the kinds of pests present and active in the temperate and colder zones are governed largely by their ability to withstand the much lower temperatures. While in some respects, such as the identity of the creatures, there may be a close parallel between the nature and kind of infestation in different territories, the seriousness of the problem of infestation may vary widely in local acceptance between one part of the world and another. In those territories which may produce substantial export surpluses for which there is keen demand elsewhere there may be little or no inducement for those who trade at the export end voluntarily to incur expense for the benefit of the receiving end unless appropriate standards of condition are recognised and enforced in the various grades. In the world produce market it should be to the interest of all parties that appropriate measures are taken to prevent or control infestation as near as possible to the source, and the market price of the commodity should be sufficient to include coverage of the cost of disinfestation or protection at the stage where it is most likely to be of real benefit.

Where the oceans separate producing and consuming territories the surpluses entering into international trade are of course subject to conditions very different from those which apply to overland routes between growing and consuming areas.

The world's crop production in large part is consumed at places away from the actual growing area and apart from infestation losses occurring during the growing stages, there is a great amount of loss from this cause taking place in transit, storage, milling and other processing up to the final distribution to the consumers.

In many of the vast growing areas in the tropical and subtropical countries commodities intended for export to other countries or territories have to go through a complicated system so that the output from many growers over wide areas may be gathered together and canalised along the main traffic routes down to the ports for ocean transport or across land frontiers to overland destinations. In the course of these operations and apart altogether from what may happen on the growing site itself, use may have to be made of many different sets of accommodation and facilities in completion of the chain between seller and buyer, or grower and consumer. There is every possibility that all or any of these facilities and accommodation may have derived residual infestation from earlier use in commodity transport or storage with the result that at these different points in the trading chain the current commodities may acquire infestation by storage insects and possibly small animals. The infested condition may well increase in intensity according to the time and climatic conditions under which the commodity is exposed to infestation risk. Having acquired infestation the commodity may communicate it to all other commodities, structures, and facilities with which it may come into contact, and all the time its own condition may be rapidly worsening.

The importance of this consideration may be realised when thought is given to the opportunities and possibility for the acquisition of infestation as the normal trading technique is followed. The grower may garner his harvest and hold it in storage until it is transported to one of the gathering stations. There it may be merged with the production of many other growers until the whole bulk can be transported to a major assembly point. There a merger may again occur with still more bulked consignments from other gathering stations subsidiary to the major assembling centre. Infestation in any individual consignment in the whole bulk may, unless special precautions are taken, extend to the whole of the aggregated commodities at the assembly point. It may then be that the aggregated commodity may be put on rail,

Modern Dry Docks—*continued*

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Food Infestation at Ports—continued

road or inland waterway for transfer to the port, etc., in the course of which journey the problem of residual infestation in the transport units may be an added and serious factor.

Ideally, when the port is reached it would seem to be convenient that all the shipment goods brought down to the port should pass through one bottleneck where they might be disinfested before loading to ship but every practical port officer knows full well that this is far from always possible in port practice. The capacity of the port, the berthing of ships, the availability of lighters and loading appliances and the actual arrivals of ships cannot all be synchronised with the availability of export goods in the part of the port accommodation selected for the adoption of disinfestation treatment in such quantities as can match the availability of shipping space in vessels waiting in the port. In times of port pressure certain urgent commodities may have to be worked down to the actual shipping place without passing through the treatment station. On the other hand the treatment station itself may be so congested that there is actual shortage of treated cargo sufficient for the ships awaiting loading, in which case untreated cargo may be moved down for loading to ship in preference to incurring waste of shipping space. And after all, the port accommodation itself, the port lighters, or the ships' holds may already be infested from previous cargoes, and possibly from other ports, in which case all previous treatments for disinfestation may have been of limited value.

From all this it may be noted that it is a serious and seemingly almost intractable problem to ensure that the exportable produce of a large territory is made available at its frontiers for further transport in a condition reasonably clear of infestation, yet, search for a solution is in the general interest.

In recent years much has been done on the West Coast of Africa to disinfest large stocks of produce intended for export prior to actual shipment. That is a considerable step forward but its main value is with large heads of supply stored near to the intended shipment port where the quantity available is in much greater volume than can be shipped in the immediate future.

Those in the receiving countries who are concerned with the handling of imports susceptible to infestation may at times feel that more ought to be done in the countries of origin to ensure that there is relative freedom from infestation in the goods they receive. Assuredly something ought to be done but the real problem is what that something ought to be, who should do it, and where it should be done.

It might be thought that this will go a long way towards solving this problem, but this is by no means certain, if human wit and endeavour are not applied to the elucidation of this most troublesome and expensive matter. It is not unlikely that there may be in some producing territories exportable surpluses for which there is no demand. It might be that at the same time there are countries who cannot afford to pay the price for the surplus commodities available elsewhere which may be much needed for consumption in their territories. Circumstances may arise where world prices are against the seller, who may for considerable periods be left in possession of his stocks, and during that time there may be substantial deterioration of condition owing to infestation. Ultimately a market may be found for supplies which have been stored for too long, even if that market involves a degrading of the commodity from its original classification. When commodities in that sort of condition are hawked about the world, there may result a deplorable lowering of transit commodity standards and of port storage and transport facilities. The transport and storage trades whether concerned with the ocean or land aspects are often accused of responsibility for infestation losses. In general this accusation is undeserved, although there are undoubtedly cases where old substandard transport and storage facilities work out their time, so to speak, in catering for commodities degraded by reason of infestation.

In the commodity markets of the world, it is too often the case that the buyer never sees the goods he orders until they are delivered to him. It may be quite true that in many commodity trades there is appraisal to determine the rebates to which the buyer may be entitled because of inferior condition, but such price reductions based on degrees of infestation of the particular commodities, do nothing towards controlling that infestation, and in such cases may set up a complacency on the part of the receiver towards the continuance of infestation which ought to be rectified and not be passed on in the trading chain.

In view of the grave effects of all this cross-infestation, which has remarkable facility in spreading itself both as to nature and extent, along the traffic routes of the world, the whole problem of commodity infestation is one and indivisible and should be treated accordingly on an international basis, for which purpose it is essential that the co-operation of all interests should be sought diligently.

Most of the major ports of the world may point with pride to a disinfestation station of sound and modern technical construction. The real test, however, of the efficiency of a port by way of reasonable guarantee or shipment in clean and sound condition, depends primarily on the extent to which infested goods ultimately intended for export are passed through and do not bypass the cleaning station and are shipped into clean and not infested holds for ocean transport.

Under the influence of the Food and Agriculture Organisation of the United Nations and of other agencies much has been done in many territories in the past decade to protect the current crops and the food reserves, but the conversion from the primitive conditions in vast territories is far beyond local resources, and world economic conditions impose limits on the scale of help to be expected from better circumstanced communities for their less fortunate brethren.

It does not seem that a special responsibility rests upon those who operate in the world's commodity markets, whether they are the merchants buying in from the native producers, the interests responsible for the collecting centres and assembly stations, the transport undertakings and the ultimate handlers in the disposal of the commodities, to endeavour at the commencement of their respective stages to lay down standards of hygiene for the commodities they purpose to acquire, or accommodate, and to pass them on in the trading chain in reasonably good condition. It may be said that this care and concern is already part of the standard practice of the various interests concerned in the marketing and movement of commodities, but facts speak for themselves and infestation is not either spontaneous or accidental, neither is it inevitable nor incurable.

The only sound way of getting the upper hand of infestation in food commodities, storage and transport is at one and the same time to fight it back progressively to its source and to chop off its ugly head wherever in the trading chain it raises itself.

The world-wide implications of such an attack upon the problem are neither overlooked nor under-estimated. Granted that it is a big and difficult subject, extending in its ramifications over most parts of the world, that is no reason for assuming that the problem is insoluble.

It is in the first degree necessary that a country which depends chiefly on imports of primary food commodities should take steps to ensure that its internal infestation problem is being tackled energetically. It is then the better able to convince the outside world and in particular the countries from which it draws its supplies, that pressure on the exporting countries to send clean food in clean transport is backed by the evidence of determination to clean up in the importing territory, so that it may be there for all the world to see that improvement in the conditions under which food is exported will not be wasted when that food reaches the importing country.

It is not overlooked that currency restrictions in the world have, or may have, an important bearing on the purchasing power of those territories which have to compete in the world's markets for the available supplies on such terms as they can afford. However that may be, the more that preferred buyers buyers press for higher standards of condition, the more likely it may be that those standards will become common form for the benefit of the producers as well as the consumers. World market prices certainly should not be linked with sub-standard commodity condition. In the present connection that merely has the effect of infested materials being hawked about the world and absorbed by territories least able to pay for the continuing damage so occasioned.

Oil Tanker Cleaning Installation on the Tyne

Design and Construction of New Receiving Berth

By " ANCAIOS "

The August, 1955, issue of this Journal included a short account of the opening of a new tanker cleaning installation at North Shields, and a description of the processing plant provided.

The design and construction of the reception berth involves certain novel features and it is hoped that the following additional information will be of general interest.

The siting of the installation was influenced by:—

(a) The necessity for economy in capital expenditure.

(b) The fire risk involved in the handling, oil separation and oil storage processes.

(c) The necessity for fencing and compounding the installation on an isolated site.

(d) A nearby depth of water and berthing length necessary for accommodating ocean tankers of up to 26,000 tons D.W. Tankers would arrive for cleaning in the unladen condition so that a depth of water of 25-ft. at L.W.O.S.T. was required.

(e) Ease of berthing tankers in relation to other river traffic, the prevailing wind, the approach angle and the set of the tide.

Having regard to these factors it was decided that the installation should be built at the west side of the entrance of the old Northumberland Dock (the gates of which have now been removed) and to site the reception berth nearby on the river frontage, alongside the clay-cored wall or dam separating Northumberland Dock from the Tyne. This wall is some 30-ft. wide at the crest, has stone-pitched side slopes of 1 in $1\frac{1}{2}$ and an underwater dredged slope on the riverward side of about 1 in 2.6.

The berth provided is some 850-ft. in length, having 6 heavy-duty bollards sited on the river wall, and two energy-absorbing dolphins at 200-ft. centres which carry bollards for the spring ropes. A general view of the dolphins and timber interconnecting gang, and approach gangway, is shown at Fig. 1, the photograph having been taken when construction work was nearing completion.

The berthing requirement was for each dolphin to be capable of absorbing the energy of a 26,000 ton tanker with an approach velocity of 1-ft. per second. The displacement of such a tanker in the unladen condition, but with 12,000 tons of water ballast aboard, is 23,000 tons, and the maximum kinetic energy of this vessel is

$$E=\frac{23,000}{2g}=360 \text{ foot tons.}$$

Fig. 1. Tanker Cleaning Berth—general view from West Dolphin.

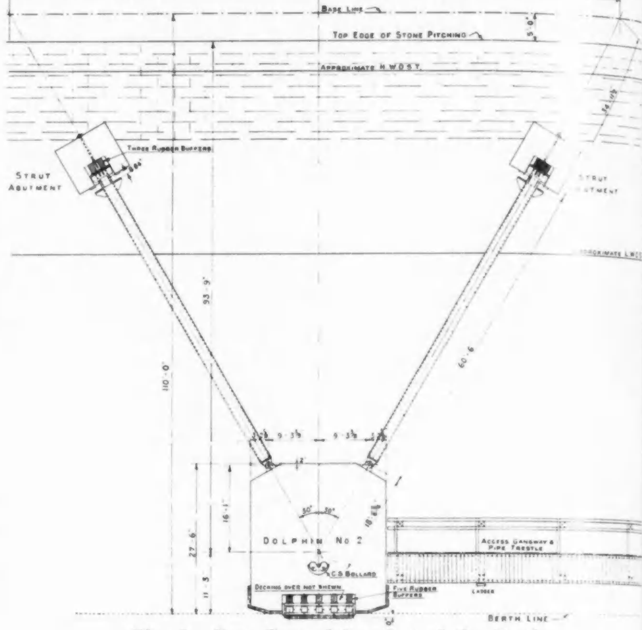


Fig. 2. Part General Lay-Out of the Berth.

The effective proportion of the total K.E. transmitted to the dolphin on impact is[1]

$$\frac{E}{1+C^2/k^2}$$

where " C " denotes distance of the mass centre of the vessel from point of contact with the quay, and " k " is the radius of gyration about a vertical axis through the vessels' mass centre. The required absorption capacity worked out at 243 foot tons, a high figure, normally requiring a massive and expensive form of construction. However, the employment of an ingenious arrangement of cylindrical rubber buffers in conjunction with a flexibly-piled dolphin and two supporting "abutment" dolphins, provided a system having the required energy-absorption capacity.

It will be seen from Fig. 2, part of the general dolphin layout, and from Fig. 3, that the vessel's berthing energy is absorbed by the deflection of five steel box piles forming the fender unit, the compression of five cylindrical rubber buffers immediately behind the fender piles, the deflection of eight steel box piles which support the main dolphin slab, the compression of six rubber buffers at the shoreward ends of two heavy tubular steel struts and finally the deflection of eight steel box piles in two strut abutments.

Fig. 4 is a close-up view of a fender unit prior to completion. The five cylindrical rubbers, four of which are visible in the photograph, are all arranged to compress up to 10-in. axially, thus absorbing a total of 85.5-ft. tons of energy. This quantity is computed from the results of actual load-deflection test curves made on the buffers, and it is remarkable that their unstressed length of 19-in. could repeatedly be compressed by 10-in., with complete recovery.

Fig. 5 shows the arrangement of a 3-buffer unit at the shore end of one of the tubular steel struts, and as will be shown later, these buffers were only required to compress through 8.84-in. as any greater compression would overstress the **dolphin** piles (by virtue of the larger deflection induced in the latter). It will thus be seen that the whole energy-absorbing system is carefully balanced so that the strength/deflection characteristic of one part does not overstress that of another, and in fact several trial calculations and adjustments were required before the sizes and dimensions of the complete structure were decided upon.

Design Assumptions

A safe maximum transitory stress in the H.T. steel box piles of 22 tons per square inch was allowed. The piles of the main dolphins required to be 70-ft. long No. 5 Larssen Box Section

Oil Tanker Cleaning Installation on the Tyne—continued

Fig. 3. View showing dolphins, tubular struts and abutments.

and were assumed to have fixity in the 4-ft. 6-in. thick concrete deck slab, and in the ground. The ground, which comprised about 30-ft. of silty sand overlying firm sand, was assumed to be perfectly elastic under transitory loading. The point of contraflexure in the piles was assumed at 25-ft. below the bottom of the deck slab, the pile being considered as stiff in comparison with the ground.

The depth below ground level of the point of no displacement of the pile (point of fixity) was calculated from the formula[2]:—

$$p = \frac{d(2d+3h)}{3(d+21)}$$

and with an average penetration of 25-ft.,

$$p = 15\text{-ft. approximately.}$$

Deflection of Dolphin Piles

The Moment of Resistance for a No. 5 Larssen Box Pile is 3,960 tons inches at maximum stress, whence the load at the end of a 25-ft. cantilever must not exceed

$$\frac{3{,}960}{25 \times 12} \quad \text{or 13.2 tons.}$$

The deflection under this load can be shown to be limited to 11-in., whence the energy absorbed by the eight piles of each main dolphin

$$= \frac{8 \times 13.2 \times 11}{2 \times 12} \quad = 48.5 \text{ ft. tons.}$$

Deflection of Abutment Piles

Similarly, the strength of the abutment piles (47 tons per pile maximum) limits their deflection to 0.86-in., so that the total energy absorption of the eight piles in the two strut abutments must not exceed 13.5 ft. tons.

However, the compression of the three rubber buffers at each strut abutment is limited, as explained above, to a maximum of 8.84-in., at which compression each buffer exerts a normal maximum load on the abutment of 40 tons (from the load/deflection graph of the buffer), whence the normal maximum load on each abutment is $3 \times 40 = 120$ tons, with a consequent deflection of the abutment piles of 0.55-in., and an energy-absorption of 5.5 ft. tons.

Deflection of Rubber Buffers at Abutments

As shown above,

Maximum deflection of dolphin piles=11-in.

Eleven inches movement of the dolphin imparts 9.7-in. movement (geometrically) in each strut.

Hence as the abutment piles deflect 0.86-in., the compression of the abutment buffers

$$= 9.7 - 0.86 \qquad = 8.84\text{-in.}$$

The total energy absorbed by the six abutment buffers, obtained from their load/deflection graph, for 8.84-in. deflection is found to be 76.2 ft. tons, and the force required to deflect each buffer to be 40 tons.

The maximum force on the strut stops is therefore

$$= (4 \times 47) - (3 \times 40) = \mathbf{68} \textbf{ tons.}$$

Deflection of Fender Piles

The high tensile steel fender piles, 65-ft. long, are considered as encastré in the ground at a depth of 10-ft. 4-in. below dredged level.

The maximum allowable cantilever force at rubber buffer level is

$$= \frac{M.R.}{L} \qquad = 6.13 \text{ tons}$$

and the deflection at this load

$$= \frac{WL^3}{3EI} \qquad = 29.2\text{-in.}$$

Actually only 11-in.+10-in.=21-in. deflection is required, when the force at rubber buffer level=4.4 tons.

The total energy absorption of the five fender piles thus

$$\text{becomes} = \frac{5 \times 21 \times 4.4}{12 \times 2} = \mathbf{19.3} \text{ ft. tons.}$$

Deflection of Rubber Fender Buffers

The force required to compress a rubber buffer by 10-in. is 60 tons and the energy absorption of five such buffers is 85.5 ft. tons.

The energy absorption figures can therefore be summarised as follows:—

	Maximum ft. tons	Normal ft. tons
Fender Piles	19.3	19.3
Rubber Buffers to Fenders ...	85.5	85.5
Dolphin Piles	48.5	48.5
Rubber Buffers to Struts ...	76.2	76.2
Abutment Piles (two abutments)	13.5	5.5
	243.0	235.0

Horizontal Forces and Stresses

The force imparted by a berthing vessel is balanced by the total reaction on the piles from the ground. These forces can be summarised as follows:—

Fig. 4. A fender unit prior to decking-in.

Oil Tanker Cleaning Installation on the Tyne—continued

	Maximum tons	Normal tons
Shear Force on Fender Piles ...	22.0	22.0
Shear Force on Dolphin Piles ...	105.6	105.6
Shear Force on Abutment Piles, resolved perpendicular to dolphin face	326.0	208.0
Total maximum force on vessel	453.6	335.6

It will be seen that the strain energy of compression of the tubular steel struts has been neglected. These struts, 24-in. internal diameter and 59-ft. 9-in. long between the pin joint and the heavy fabricated steel abutment stop, are made up from ½-in. thick M.S. plates, shop-formed and welded. Their slenderness ratio is 82.75, for which a safe working stress of 4.73 tons per square inch is allowable. The largest axial load to which the strut can be subjected is 4 × 47 tons, developed by the strut abutment (see above) and applying the strut formula

$$M\ max = \frac{wEI}{P}\left(1 - sec.\ \sqrt{\frac{P}{EI}} \cdot \frac{L}{2}\right)$$

it can be demonstrated that the sum of the direct thrust and bending stresses is under 5 tons per square inch.

Fig. 5. 3-Buffer Unit retained by 4-in. dia. x 9-ft. 9-in. central bolt.

General Notes

The five box poles of each fender unit are rigidly braced together at 4-ft. 9-in. intervals down to low water level, by pairs of 5-in. x 4½-in. R.S.Js. strongly braced and bolted together between the piles and at the ends of the unit. The units are retained by two adjustable heavy chain retaining slings, and are protected on their faces by 12-in. x 6-in. vertical hardwood rubbing timbers.

The deck slabs of both dolphins and abutments are designed to withstand the full theoretical couple which could be induced by the piles (which are embedded to within 6-in. of the tops of slabs) and for the calculated pulls or thrusts. The top sections of these piles, down to about half tide level, are filled with concrete. The box piles of the fender unit are not so filled.

In order to combat attack by Limnoria Terebrans, all timber piles are incised and pressure-creosoted, and are sheathed from mud level to 9-ft. below L.W.O.S.T. by 18 S.W.G. aluminium to B.A. 27 standard. Joints in the sheathing are lapped 3-in., glued, fastened with aluminium alloy screws, and the whole coated with a bituminous compound.

The rubber buffers, of G.P.15 quality, are all 13-in. external diameter by 19-in. long in their unstressed state, with a 2-in. diameter central axial hole, through which a M.S. pin is positioned to locate the buffer during erection work. The buffers were designed in order to obtain the maximum possible energy absorption per pound weight of rubber.

Construction

The construction of the berth was carried out by the Tyne Improvement Commission who employed contractors for the pile driving, concrete construction and timberwork. The mild steel tubular struts were delivered to a point near the site in two half-lengths where they were aligned and field welded prior to conveyance to the berth by barge. A 5-in. x ½-in. thick backing ring was inserted into one half section and welded internally by full ⅜-in. fillet welds. The second half section was placed over the spigot thus formed and, the tube wall being chamfered ½-in. deep, the joint was made by a 70° single vee butt weld.

The longest of the steel box piles were taken to the site by barge and were driven open-ended, to the required level, the recorded sets being satisfactory in every case. It is interesting to note that with a pentration into sand of about 25-ft. the mud level inside and outside the box piles was approximately equal upon completion of driving. The dolphin and abutment piles were temporarily braced, and the deck slabs 4-ft. 6-in. and 6-ft. respectively in thickness, were poured in two and three lifts, the concrete being conveyed to each unit by monorail telpher.

The contractor first constructed the timberwork portion of the berth and made use of this in order to facilitate the erection of the concrete structures. Protection work to the timber piling was carried out prior to driving.

The promised contract completion time was 15 weeks, and although this was exceeded, the berth was completed by April, 1955, in good time for the opening of the tanker cleaning installation.

The final cost of the berth was approximately as follows:—

Dredging	£14,000
Piling concrete and timberwork	£26,000
Four tubular struts	£2,000
Electrical water supply and miscellaneous ...	£2,000
	£44,000

Economics of the Design

It is considered that the design adopted proved to be remarkably economical, and in spite of a continuous rise in the cost of materials and labour the final cost was considerably less than the estimate. However, the design may be subject to criticism on the grounds that two heavily-piled dolphins, each supported by some 26 H.T. vertical steel box piles and without struts or abutments, would have provided an equivalent energy-absorption capacity and have been more straightforward to design and construct. However, the strutted dolphin design adopted has a higher ultimate resistance to collapse and in addition gives greater lateral stability against glancing berthing blows and mooring rope stresses. A 26-pile dolphin would be of greater size than the 8-pile dolphins adopted so that there would have been no saving in concrete and reinforcement quantities. The latter design would also have involved an additional 1,960 lineal feet of box piling at a cost of about £12,000, as compared with the cost of the four tubular steel struts and six rubber buffers.

Acknowledgment

We are indebted to the Tyne Improvement Commission for permission to reproduce the above photographs.

REFERENCES

[1] Proc. I.C.E. Vol. 5. Paper No. 6126.
[2] J.I.C.E. Vol. 27. Paper No. 5519 (Correspondence).

Extension of Prince George Wharf, Nassau

It has recently been announced by the Board of Pilotage that final plans have now been drawn up to extend by 550-ft. the existing 600-ft. long Prince George Wharf at Nassau in the Bahamas. Tenders for construction will be invited shortly.

The present wharf was built in 1928 and has a depth alongside of 25-ft. at spring tide low water. It is used for berthing both passenger ships and commercial freight vessels. The rapid advance of shipping activity at the port of Nassau in latter years is due mainly to the great increase in the number of tourists visiting the islands of the Bahamas.

Book Reviews

Reinforced Concrete. By J. McHardy Young, B.Sc.(Glas.), M.I.C.E., M.I.Struct.E. Published by Crosby Lockwood & Son, Ltd., 26, Old Brompton Road, London, S.W.7. Price 12s. 6d. net.

The third edition of this book has been enlarged and revised in accordance with the new Code of Practice CP 114:57—The Structural Use of Normal Reinforced Concrete for Buildings. The stresses used throughout are in accordance with the new Code. It is interesting to note that the latter specifically refers to special concrete mixes which were mentioned in the Report of the Department of Scientific and Industrial Research (1934) but not in the previous Code of Practice which was issued in 1948. The new Code also permits the use of the load factor method of design and this has been incorporated in the text of this new volume.

In the chapters dealing with foundations and with R.C. retaining walls, the earth pressures have been based upon Civil Engineering Code of Practice No. 2 (1951)—Earth Retaining Structures, and not upon the Institution of Structural Engineers Report No. 16/1943 as in previous editions.

The book, while forming a sound introduction to the subject for students, is not claimed to be a comprehensive study of reinforced concrete.

Port of London Guide. Published by Coram (Publishers) Ltd., 20, Took's Court, London, E.C.4. Price 25s.

The 1957 edition of this guide has been completely revised by the publishers in association with Mr. A. G. Thompson, but attention is rightly drawn to the valuable work contributed by the late Editor, Mr. Frank C. Bowen. To keep the book within reasonable limits of price and size, it has been found necessary to condense some of its contents but nothing relevant to any function of the port has been omitted.

Among the new items is a description of the Port of London Authority's system of fog warnings by wireless from North Foreland radio station. Emergency telephone numbers are given and meteorological reports for vessels outward bound, while to the account of ferries has been added some details of the cross-river tunnels and bridges. Dock labour has been dealt with in an entirely new article contributed by the Dock Labour Board, which reviews this controversial subject in the light of prevailing conditions. In view of the ever-increasing importance of the country's export trade, a fully informative article on London's export facilities has been included.

Other articles deal with the work of the immigration department, the port health authority, Customs service, pilotage service and the port's fire-fighting force. Concise descriptions are given of various associations in the port and navigational information includes high tides and table of constants; spring tides; neap tides; width of spans of bridges; and a table of distances. The directory section lists the regular shipping services using the port, repair facilities in the area and particularly useful addresses. The various docks and wharves are described and their location clearly indicated on a series of maps.

Nothing seems to have been left out of this reference book that could be of value to users of the port of London.

The Netherlands Seaports. Published by Algemeen Publiciteitskantoor, Keizergracht 188, Amsterdam-C. 328 p.p. with many illustrations.

A new edition of this work has now been issued and, as the title implies, it is a complete guide to the ports of Rotterdam, Schiedam, Vlaardingen, Maassluis, Dordrecht, Zwyndrecht, Amsterdam, Zaandam, Terneuzen, Flushing, Harlingen, Groningen, Delfzyl, Born, Stein, Maastricht, Roermond and Venlo. The book also deals in some detail with the fishing port of Ymuiden, together with the North Sea Canal. There are articles on the Dutch shipbuilding industry in past and present years, the nautical training college at Delfzyl, the National Technical Institute of Navigation and Aviation, and the maritime museums at Amsterdam, Rotterdam, Enkhuizen, Groningen and Sneek.

Almost all of the articles are in English as well as Dutch and the many illustrations assist in the description of the facilities at the various ports.

Fires in Ships. Issued free as an "M Notice," copies of this booklet are obtainable from the Mercantile Marine Offices of the Ministry of Transport and Civil Aviation, and from the Clerk of Stationery, Berkeley Square House, London, W.1.

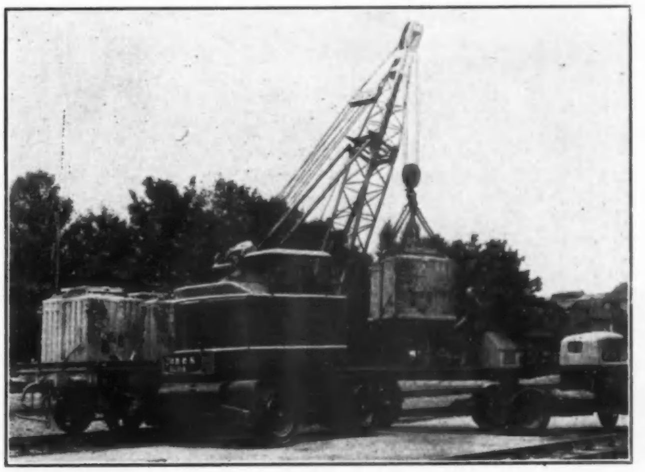
At least 130 fires are reported annually in British ships and on a few occasions the fire gets the upper hand and the ship is destroyed. Stories of some recent fires, together with conclusions about the causes and their prevention, are contained in this illustrated booklet which has been issued by the Ministry of Transport and Civil Aviation for seafarers in merchant ships and fishing vessels and for all those concerned with the designing, building and running of these ships. The Ministry hopes that attention to the lessons of this booklet will reduce the toll of loss and damage for which fires are responsible.

The text is based on the Ministry's record of casualties to United Kingdom ships which have involved fire. The booklet has been produced by the Central Office of Information, who also commissioned the illustrations.

Manufacturers' Announcements

New 10-ton Jones Crane

The Jones KL 10-6 Mobile Crane has been introduced to help meet the increasing demand for a 10-ton capacity machine, already partly catered for by the Jones KL 10-10 "Fast Travel" crane which was described in the June issue of the "Dock and Harbour Authority." It is a diesel-powered, fully-slewing machine, employing the direct mechanical drive characteristic of the Jones cranes and available on a range of chassis that gives it wide application throughout industry.



The crane, on the standard mobile chassis, handling container traffic.

Power from the Perkins engine is transmitted through a 3-speed gearbox and triplex roller chain drive and thence to the four crane motions. The full power of the engine is thus available to each of these motions, which can be operated independently or in any desired combination.

The standard mobile chassis is mounted on pneumatic-tyred restrictor wheels, these wheels affording protection to the tyre walls, preventing undue tyre deflection, and obviating risk of tipping in the event of a blow-out under the load. Drive to the wheels is through a 4-wheel differential and the steering is progressively power assisted and automatically corrected so that the action is normal whatever the position of the superstructure.

Manufacturers' Announcements—continued

Among the most important features of the new KL 10-6 is the specially designed lowering mechanism in which the lowering is accurately and smoothly controlled by governor mechanism (standard) or by an auxiliary power-lowering drive from the crane engine.

The standard jib is of the sectional, lattice-construction strut type, the basic length being 30-ft. Additional 10-ft. sections can be added, up to a total of four, and a maximum working length of 70-ft. Where additional height or outreach is required, a jury mast can be fitted, while special jibs of the swan-neck or other types can be supplied if requested.

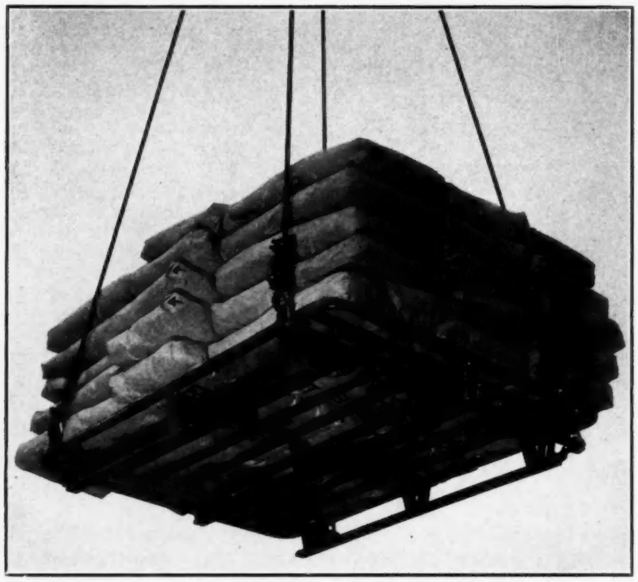
Safe working loads are calculated at not more than two-thirds of the tipping load (B.S.S. 1757-51) and outriggers, with quick-action screw jacks, are provided at each corner. Maximum S.W.L. is 10 tons at 10-ft. radius (blocked) and 6 tons at the same radius free on wheels, both using the 30-ft. jib.

In addition to the normal chassis alternative types are available to increase the range of application of the machine. These alternatives include a specially designed crane carrier truck chassis, giving speeds up to 30 m.p.h. and both shunting and non-shunting types of rail chassis. Of these, the shunting type has a shunting capacity of 125 tons.

Patented Tubular Steel Pallet

It is claimed that speedy and efficient cargo handling is assured by the use of the "Patented Markussen Pallet," which has been designed by Captain M. Markussen of Bergen, and is the result of many years study of cargo handling problems. The new pallet is half the weight of the timber pallets normally used in dock work and, in addition, storage space is reduced by seventy-five per cent. when the pallets are not in use, as they nest one inside the other and a stack of sixteeen only equals the height of four ordinary timber pallets.

Fabricated from tubular steel by Messrs. Tubewrights, Ltd. of Liverpool, they are designed for the four-way entry of fork-lift trucks and will facilitate movement on the dockside and in the hold of the ship. Lifting by crane is also simplified; the special sling employed has two bars which engage with slots at each end of the pallet. These are so designed that although the bars can be quickly disengaged when the pallet is in position, it cannot fall from the lifting gear if it meets an obstruction, such as a hatch combing, while it is being hoisted or lowered.



Tubular steel Markussen pallet, with a 2-ton load.

For goods of an irregular shape, vertical posts or side panels can be supplied. These are quickly fitted or removed. It is possible to carry all types of cargo on the Markussen pallet including bagged or sacked materials, which can be safely stacked when these pallets are used.

Aluminium Alloy Pilot Launch

Universal Shipyards (Solent) Ltd., have recently completed a 32-ft. 6-in. aluminium alloy Pilot Launch to the order of the Trinity House River Pilots' Cutter Committee at Gravesend. The design of this launch is based on the firm's standard Two-Way Tension system, modified where necessary to meet the special requirements of the Pilots' Committee.

The new Pilot Launch undergoing trials.

The launch will be used on the lower reaches of the Thames, and as she will frequently have to go alongside vessels under way in comparatively rough water, her construction is particularly robust and a solid rubber fender is fitted overall to prevent the risk of damage due to bumping alongside.

The hull is constructed of 10 s.w.g. aluminium alloy sheet with stringers of 2-in. x 1-in. x ⅛-in. tee bar fastened to frames of 1½-in. x 1-in. x ⅛-in. angle bar. The plated engine girders extend through almost the entire length of the hull. A centre keel and bilge keels of 2¼-in. x 2¼-in. x 3/16-in. tee bar provide addition strength and protection against the heavy flotsam frequently found in the Thames. The aluminium alloy sheet and sections were supplied by The British Aluminium Co. Ltd.

Since the decks will be in constant use by pilots leaving or rejoining the launch, particular care has been taken to make them safe under any working conditions. They are unusually wide and built of aluminium alloy treadplate, which is non-slip, wet or dry. They are as free as possible of fittings and encumbrances, and handrails are fitted on the coachroof and over the engine compartment for use in rough weather.

The launch has been designed for a maximum speed of 17 knots and a maximum continuous service speed of 14 knots carrying 8 pilots and 100 gallons of fuel. Her total fuel capacity is 500 gallons, which is sufficient to give approximately 100 hours continuous running without re-fuelling, during exceptionally busy periods.

The power unit is a single Perkins S.6 diesel developing 100 b.h.p. at 2,000 r.p.m. This engine, operating through a direct-drive oil-operated gear box, drives a propeller of 16½-in. x 13-in. The shaft is of 1⅞-in. diameter stainless steel with a flexible coupling to the engine output flange.